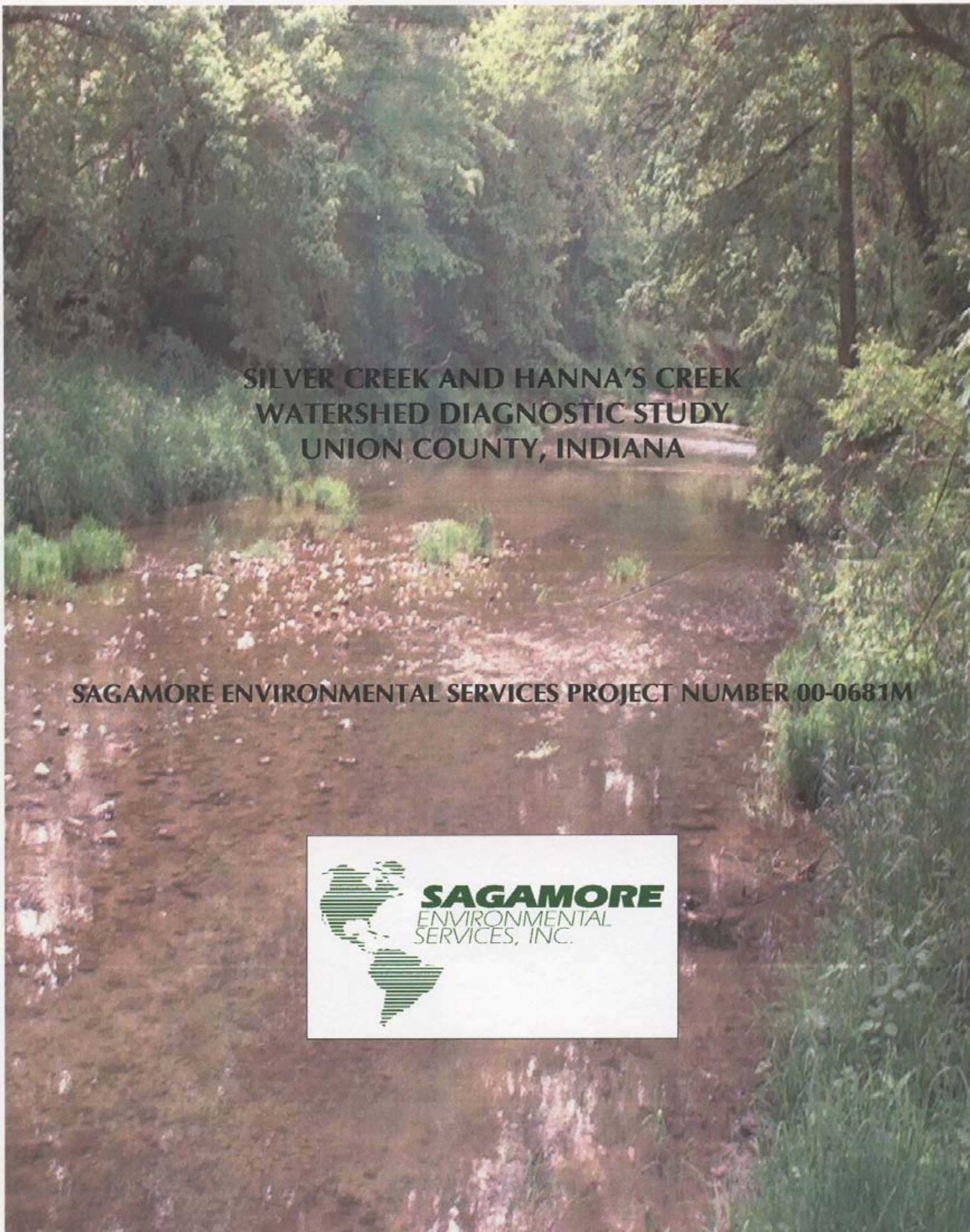


SILVER CREEK AND HANNA'S CREEK WATERSHED DIAGNOSTIC STUDY UNION COUNTY, INDIANA

SAGAMORE ENVIRONMENTAL SERVICES PROJECT NUMBER 00-0681M

SAGAMORE ENVIRONMENTAL SERVICES, INC.

SAGAMORE
ENVIRONMENTAL
SERVICES, INC.

July 31, 2002

Mr. Andy Ritzi, President
Union County Soil and Water Conservation District
2590 North Park Road
Connersville, Indiana 47331

RE: FINAL REPORT
WATERSHED DIAGNOSTIC STUDY
SILVER CREEK AND HANNA'S CREEK, UNION COUNTY, INDIANA
SAGAMORE ENVIRONMENTAL SERVICES PROJECT NUMBER 00-0681M

Dear Mr. Ritzi:

Sagamore Environmental Services, Inc. (Sagamore) has completed a Watershed Diagnostic Study of Silver Creek and Hanna's Creek in Union County, Indiana. The study included an inspection of the study area, a review of historical records, a review of regulatory agency records, and assessments of water quality, biological quality, and habitat quality. The attached report provides details of the study.

Sagamore has completed this work according to generally accepted standards and practices of engineers and environmental consultants performing such work, and the statements contained in the report are true and accurate to the best of our knowledge. This report meets or exceeds the requirements set forth in the Lake and River Enhancement Watershed Diagnostic Study Scope of Work. This report has been prepared for the use of the Union County Soil and Water Conservation District and the Indiana Department of Natural Resources.

Sincerely,

Jessica L. Manifold
Project Environmental Scientist
Sagamore Environmental Services, Inc.

K. Stephen Mohr
President

Cc: Jill Hoffman, Jim Ray, Indiana Department of Natural Resources

WATERSHED DIAGNOSTIC STUDY REPORT

Conducted as part of:

Silver Creek and Hanna's Creek Watersheds
Union County, Indiana

Project Number 00-0681M

Prepared for:

Union County Soil and Water Conservation District
2590 North Park Road
Connersville, Indiana 47331
Attn: Mr. Andy Ritzi, President

Prepared by:

Sagamore Environmental Services, Inc.
9615 East 59th Street
Indianapolis, Indiana 46216
(317) 803-2221

Executive Summary

Sagamore Environmental Services, Inc. (Sagamore) has completed a watershed diagnostic study of Silver Creek and Hanna's Creek in Union County, Indiana. The study included an inspection of the study area, a review of historical records, a review of regulatory agency records, and assessments of water quality, biological quality, and habitat quality.

The Silver Creek watershed is comprised of approximately 12,340 acres. A majority of the Town of Liberty, Witt's Station, and a portion of Whitewater State Park are included within this watershed. Silver Creek drains into Whitewater Lake. The Hanna's Creek watershed is comprised of approximately 22,119 acres. A small portion of the Town of Liberty, Kitchel, a portion of Roseburg, and a portion of the state owned property around the Brookville Lake area are included within the watershed. There are approximately 1,222 acres of highly erodible land (HEL) in the Silver Creek watershed and approximately 1,148 acres of HEL in the Hanna's Creek watershed. According to the Governor's Water Resource Study Commission, both watersheds have high soil erosion potential.

Data requests were submitted to the United States Department of the Interior, Fish and Wildlife Service (FWS) and the Indiana Department of Natural Resources (IDNR), Division of Nature Preserves (DNP) concerning protected species within the watersheds. According to the FWS, the range of the Indiana bat *(Myotis sodalis)*, a federally endangered species, and the bald eagle *(Haliaeetus leucocephalus)*, a federally threatened species, is statewide. According to the DNP, there are known occurrences of the redside dace (*Clinostomus elongates*), a state endangered species, in Hanna's Creek and a tributary, Nutter Creek.

There are 40 known archaeological sites within the watersheds. Of these, 11 have been deemed "not eligible" for listing on the National Register of Historic Places. The eligibility of the remaining 29 sites is undetermined.

There is one hazardous waste handler, one Emergency Response Notification System incident, two registered underground storage tank (UST) facilities, one Indian Department of Environmental Management (IDEM) spill incident, one County spill incident, and four confined feeding operation facilities within the Hanna's Creek watershed. There are three hazardous waste handlers, one Permit Compliance System site, two solid waste facilities, four leaking underground storage tank incidents, 16 registered UST facilities, eight IDEM spill incidents, and four County spill incidents within the Silver Creek watershed.

Previous reports published for this area are limited to one federal report and three state reports. The USGS studied the impact of sedimentation on Whitewater Lake with data from 1959 through 1988. The IDNR prepared a report describing the availability, distribution, quality and use of surface and groundwater in the Whitewater River Basin. The IDEM prepared a document in compliance with Section 305(b) of the federal Water Pollution Control Act (the amended Clean Water Act, 1987) which requires states to prepare and submit to the USEPA a water quality assessment report every two years. The Purdue Extension conducted a conservation transect study of Union County describing current and recent agricultural practices throughout the county.

Temperature and dissolved oxygen measurements were within acceptable ranges at all sample points during high and low flow sampling events as well as historic sampling. Conductivity was slightly elevated. pH was slightly caustic during low flow. Physical water conditions can fluctuate throughout the day and from season to season; therefore, any reactions to physical conditions should be based on long-term sampling.

Nitrate, nitrite, and ammonia levels were below the respective reference standards during both sampling events. Nitrate levels during high flow sampling were somewhat elevated, and are significantly higher than low flow sampling. Nitrite levels were low and well below the water quality standard; yet, were significantly higher during high flow. Ammonia levels were also relatively low.

Water quality sampling indicated elevated levels of total Kjeldahl nitrogen, phosphorous (total and ortho), fecal coliform, and turbidity. Ortho phosphate analysis indicates that most, but not all of the phosphate in the watersheds is dissolved. During high flow sampling, the water in both creeks was brown and cloudy, conversely, during low flow sampling, the water was clear and colorless. As such, the turbidity readings were relatively high during the high flow event, and very low during the low flow event. Fecal coliform counts were significantly above the standard at all sampling locations during high flow sampling. TKN concentrations were above the referenced standard at five locations.

Macroinvertebrate sampling revealed a high concentration of species intolerant to pollution. A greater number of species indicative of good water quality were collected in Hanna's Creek versus Silver Creek. Yet, the Hilsenhoff Biotic Index indicated that overall the watersheds were ranked as "good".

The QHEI Assessment revealed that most sites posses adequate habitat for warm water species. Deficient instream cover was slightly problematic in Silver Creek. Channel Morphology was low at locations 3 and 6. This was primarily due to low sinuosity and low development. Pool/Glide and Riffle/Run Quality is the only category that is deficient throughout most of both watersheds. This deficiency was most equated to depth, morphology, and substrate. Sample location 6 was the only site that was below 60. The evaluation revealed a high concentration of silt within the substrate, low sinuosity, poor development, and no riffles.

A review of historic aerial photographs of Whitewater Lake and Brookville Lake has revealed significant changes in shoreline morphology at the points of discharge of Silver Creek and Hanna's Creek, respectively, due to sediment loading.

Based on data collected during this watershed diagnostic study, there are three significant issues within the Silver Creek and Hanna's Creek watersheds. They are prioritized as 1) Sediment, 2) Fecal Material, and 3) Phosphorous. To mitigate these issues, Sagamore recommends the following, prioritized actions: 1) continue BMP efforts; 2) biofiltration along tributary discharging wastewater treatment facility; 3) sediment basins at discharge of both creeks; 4) wetland enhancement at discharge of both creeks; and, 5) mitigation of impacts at horse crossing on Silver Creek.

Table of Contents

Attachments

Appendices

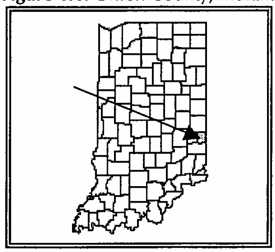
1.0 Introduction

Sagamore Environmental Services, Inc. (Sagamore) has completed a watershed diagnostic study of Silver Creek and Hanna's Creek in Union County, Indiana. The study included an inspection, testing and sampling of the study area; a review of historical records; and a review of regulatory agency records. The attached report provides details of the diagnostic study. Referenced attachments are included at the end of each chapter. A map identifying the location of Union County, Indiana is included in Figure 1.1.

1.1 Description of Study

The purpose of a watershed diagnostic study is to identify the quality of the waterways within the watershed relative to past and present operations, and to make recommendations for restoration and mitigation. This is achieved by conducting field inspections, biological and chemical sampling, and reviewing available historical documents and various local, state, and federal regulatory agency files that may disclose environmental concerns within the watershed.

Figure 1.1: Union County, Indiana



1.2 Description of Study Area

Union County is located in east-central Indiana at West 85°02′, West 84°49′, North 39°44′, North 39°31′ and is comprised of approximately 103,398 acres. The county is bound to the north by Wayne County, to the south by Franklin County, to the west by Fayette County, and to the east by Preble County, Ohio. Union County is within the Whitewater River Watershed. A map of the study area based on 2000 aerial photography is included as Attachment 1.2.

The focus of this diagnostic study is the Silver Creek and Hanna's Creek watersheds in Union County. Collectively, the watersheds comprise approximately 26% of Union County (32,559 acres).

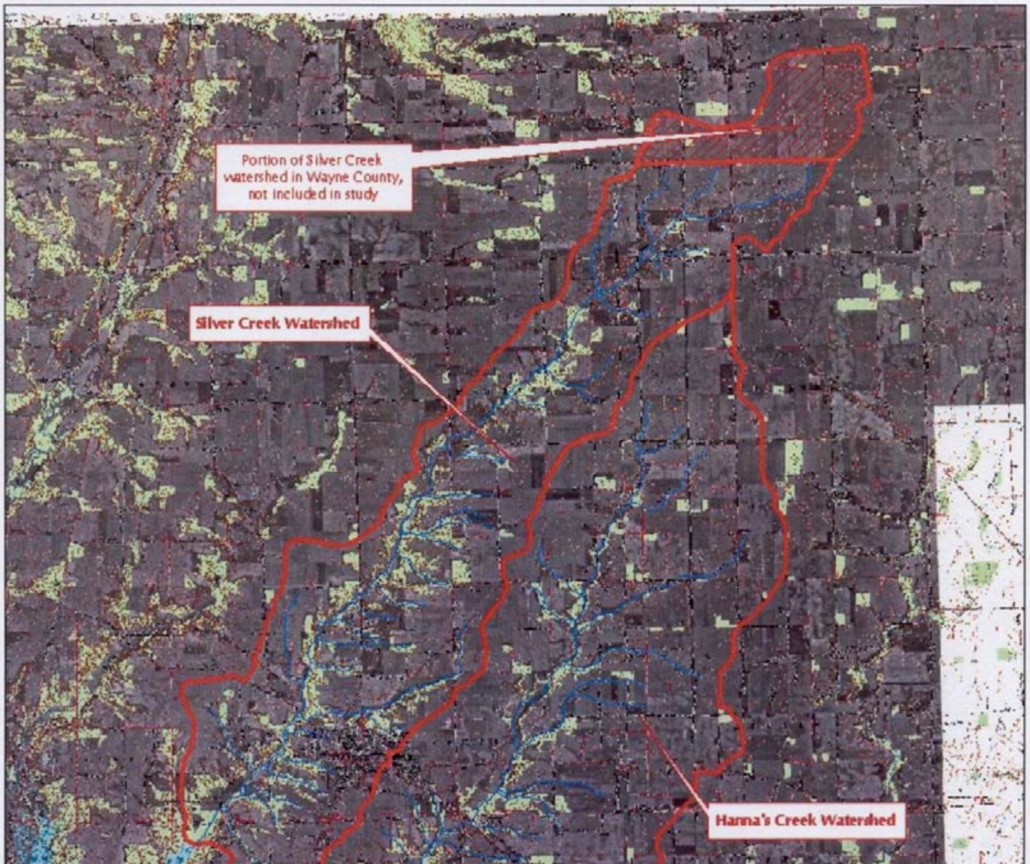
The Silver Creek watershed (14 digit hydrologic unit code 05080003070130) includes approximately 12,340 acres. Approximately 2,000 acres of the Silver Creek watershed are located in Wayne County, Indiana and are not included in this study. A majority of the Town of Liberty, Witt's Station, and a portion of Whitewater State Park are included within this watershed. Silver Creek drains into Whitewater Lake.

The Hanna's Creek watershed (14 digit hydrologic unit code 05080003070150) includes approximately 22,119 acres. A small portion of the Town of Liberty, Kitchel, a portion of Roseburg, and a portion of state owned property around the Brookville Lake area are included within the watershed.

ATTACHMENT

1.1. Watershed Boundary map

Attachment 1.1. Watershed boundary based on 2000 aerial photography.



Source: USDA Data Gateway

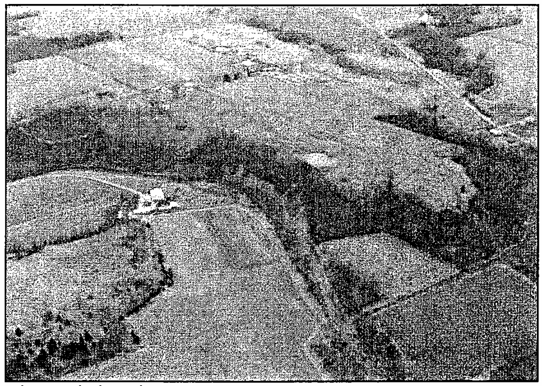
2.0 PRELIMINARY REVIEW

The preliminary review included an inspection of the study area, a review of historical records, and a review of regulatory agency records. The following chapter provides details of the preliminary review.

2.1 PHYSICAL SETTING

This section includes information concerning the physical characteristics of the Silver Creek and Hanna's Creek watersheds. Information was reviewed a the FWS, the United States Depart-ment of Agriculture (USDA), Natural Resources Conservation Service (NRCS) for Union County, the IDNR Division of Water, the IDNR Division of Parks and Recreation, the IDNR Division of Nature Preserves, the Union County SWCD, the Union County Planning Commission, and the Liberty Public Library.

Figure 2.1.1: *Aerial view of Silver Creek*



Photographed March 27, 2001

2.1.1 Climate

Union County has a continental climate. The area has an average frost-free period of 155 days. The average date of the last killing frost in spring is May 3, and the average date of the first frost in autumn is October 5. On the uplands, the frost-free period generally begins about a week earlier than on the lowlands and ends a week or more later. Consequently, the growing period may be somewhat longer on the uplands. Annual climatologic data for Union County is included in Table 2.1.2.

Table 2.1.2: Climatologic data for Union County

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Avg. High	36°F	40°F	52°F	63°F	74°F	82°F	86°F	84°F	78°F	66°F	53°F	41°F
Avg. Low	15°F	18°F	28°F	37°F	47°F	56°F	61°F	59°F	52°F	39°F	31°F	22°F
Mean	26°F	29°F	40°F	51°F	61°F	70°F	74°F	72°F	65°F	53°F	43°F	32°F
Avg. Prec.	2.4 in	2.4 in	4.0 in	3.8 in	4.7 in	3.6 in	4.6 in	3.9 in	2.7 in	3.0 in	3.4 in	3.3 in
Record High	75°F (1950)	75°F (1999)	84°F (1986)	89°F (1986)	94°F (1987)	102°F (1988)	103°F (1954)	103°F (1983)	104°F (1951)	93°F (1953)	86°F (1958)	76°F (1982)
Record Low	-31°F (1994)	-22°F (1951)	-9°F (1980)	16°F (1982)	25°F (1966)	36°F (1972)	44°F (1972)	40°F (1965)	30°F (1995)	15°F (1952)	-7°F (1958)	-20°F (1989)

Source: National Weather Service

Rainfall is fairly uniform throughout the year. On average, most rainfall occurs in May with the least occurring in September. In some areas, crops are damaged frequently by lack of moisture during July and August. Damage from hail is occasional and isolated, while lightning and

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tornado damage is rare. Only two recorded tornados have occurred in Union County since 1950 (March 11, 1955 and November 22, 1992). The average snowfall is 25.7 inches annually, with most occurring between December and March.

2.1.2 Land Use

A majority of the land within the watersheds is agricultural. Wooded areas within the watersheds are concentrated mostly along stream and tributary channels. These wooded areas are comprised mostly of deciduous trees. A majority of the developed land in the watersheds is of mixed use, including residential, commercial, and industrial. The Liberty Country Club Golf Course is north of Liberty in the Silver Creek watershed. The area west of Liberty is almost entirely residential. A variety of developed land uses are scattered throughout the watersheds. Table 2.1.3 details land use information within the watersheds. A Land Use Map is included in Attachment 2.1.1.

Table 2.1.3: Land Use (acres)

Land Use	***Watersheds***		***Total***
	Silver Creek	***Hanna's Creek***	
Boundary	9,696	17,469	27,165
Wooded	1,489	3,570	5,059
Golf Course	146	-	146
Commercial/Industrial	24	-	24
Mixed	328	48	376
Residential	307	9	316
School	19	-	19

2.1.3 Soils and Geology

The major soil associations underlying the watersheds are described below. A General Soil Map of the watersheds is included in Attachment 2.1.2. Soil information was compiled from the *Soil Survey of Fayette and Union Counties, Indiana* (1952).

Fincastle-Crosby Association (map symbol: 82): These are nearly level areas consisting of a thin silt layer over loamy till that are somewhat poorly drained. These soils are calcareous at 24 to 42 inches. Fincastle and Crosby silt loams occur on slightly elevated areas. Other soils included in this association: Cope silt loam and silty clay loam and Brookston silt loam (swales and depressions); and Russell silt loam and Miami silt loam (slightly higher and more sloping areas).

Xenia-Celina (map symbol: 83): These are nearly level to gently sloping areas comprised of a thin silt layer over till that are moderately well drained. These soils are calcareous at 24 to 42 inches. Xenia and Celina silt loams occur on gently sloping areas near heads of drainageways and on low knolls on the divides. Other soils included in this association: Russell silt loam and Miami silt loam (slightly higher and more sloping areas); Fincastle and Crosby silt loams (nearly level, slightly elevated areas); and Cope silt loam and silty clay loam and Brookston silt loam (swales and depressions).

Russell-Miami (map symbol: 24): These are sloping to steep areas which of a well drained, thin variable silt layer over till. These soils are calcareous at 30 to 34 inches. Russell and Miami silt loams occur on sloping areas along drainageways and on low knolls. Other soils included in this association: Xenia and Celina silt loams (gently sloping areas); and Fincastle and Crosby silt loams (nearly level, slightly elevated areas).

Genesee-Eel (map symbol: 74): These are nearly level areas within flood plains. These soils are comprised of neutral to slightly calcareous materials. Genesee and Eel silt loams occur in level areas. Other soils included in this association: Shoals silt loam (stream bottoms and meander channels).

Fincastle-Brookston (map symbol: 82): These are nearly level areas containing a silt layer over till that are somewhat poorly drained to very poorly drained. Light and dark patterning is common. These soils are calcareous at 42 to 70 inches. Fincastle silt loam occurs on slightly elevated areas. Brookston silt loam and silty clay loam occur in swales and depressions. Other soils included in this association: Cope silt loam and silty clay loam and Reesville silt loam (swales and depressions); Russell silt loam and Xenia silt loam (slightly higher and more sloping areas).

Russell-Hennepin (map symbol: 84): These are sloping to steep areas comprised of a silt layer over loamy till that are predominately well drained. These soils are calcareous at 42 to 70 inches. Other soils included in this association: Fairmount silty clay loam (adjacent to valleys of streams and drainageways); Xenia silt loam (slightly higher and more sloping areas); Fincastle silt loam (nearly level, slightly elevated areas); and Cope silt loam and Brookston silt loam (swales and depressions).

Moraine – a mixed accumulation of material deposited by glacial ice

Kame – a mound of material deposited from an accumulation of sand and gravel in pockets within receding glaciers

Colluvial – soil material accumulated at the base of steep slopes as a result of erosion

Paludal – of or relating to a wetland, marsh, bog, etc.

The watersheds are located within the Crawfordsville Moraine, a segmented recessional ***moraine*** marked by many ***kames*** and a large outwash plain. Unconsolidated deposits underlying the watersheds predominantly consist of ground-moraine till of the Trafalgar Formation that includes some ice-contact stratified drift. Deposits along Silver Creek and Hanna's Creek are comprised of mostly alluvium of the Martinsville Formation, but include some ***colluvial*** and ***paludal*** deposits. Large volumes of water from rapid ice melts have eroded deep valleys in this area producing the major tributary valleys of the East and West Forks of the Whitewater River. These valleys have functioned as sluiceways for glacial meltwaters and extensive valley trains have developed within their courses.

Union County is entirely located in the Dearborn Upland bedrock physio-graphic unit. The Dearborn Upland is a highly dissected bedrock plateau of rugged relief. Bedrock underlying a majority of the watersheds is Maquoketa Group shale and limestone of the Ordovician Age. The northern portion of the watersheds is underlain by Silurian Age limestone, dolomite, and shale.

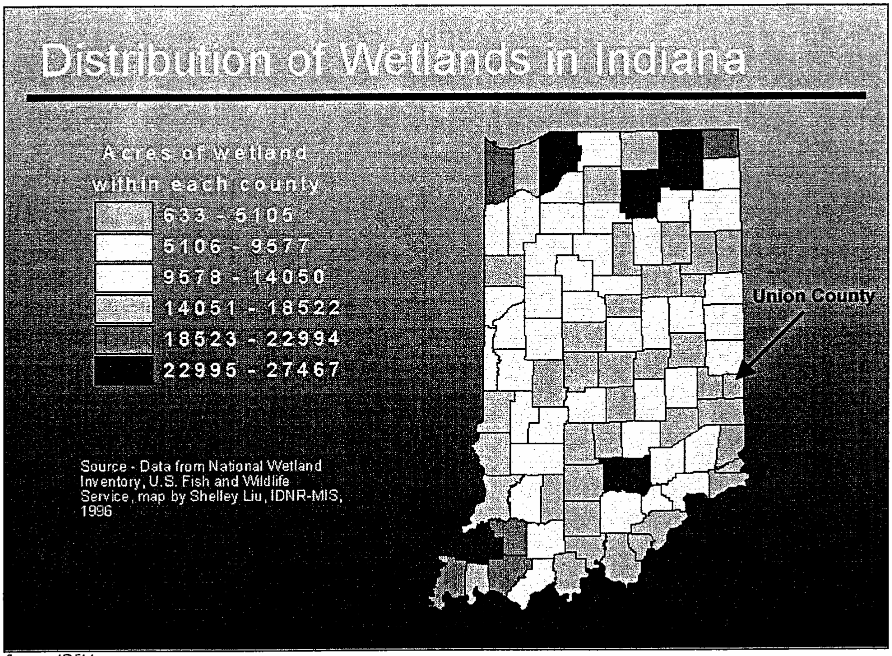
2.1.4 Highly Erodible Land (HEL)

According to USC: Title 16, Chapter 58, subchapter 1, the term "HEL" means land (i) that is classified by the Soil Conservation Service as class IV, VI, VII, or VIII land under the land capability classification system in effect on December 23, 1985; or (ii) that has, or that if used to produce an agricultural commodity, would have an excessive average annual rate of erosion in relation to the soil loss tolerance level, as established by the Secretary of Agriculture, and as determined by the Secretary of Agriculture through application of factors from the universal soil loss equation and the wind erosion equation, including factors for climate, soil erodibility, and field slope. There are approximately 1,222 acres of HEL in the Silver Creek watershed and approximately 1,148 acres of HEL in the Hanna's Creek watershed. A map of HEL within the watersheds, compiled in 1988, is included in Attachment 2.1.3. According to the Governor's Water Resource Study Commission, both watersheds have high soil erosion potential. A map of the soil erosion potential for study region nine of the study is included in Attachment 2.1.4.

2.1.5 Wetlands

Wetlands are vital to the survival of various animals and plants, including threatened and endangered species such as the Indiana bat and the bald eagle. The FWS estimates that up to 43% of the threatened and endangered species rely directly or indirectly on wetlands for

Figure 2.1.4: *Wetland Distribution*



Source: IDEM

survival. For many species, such as the wood duck, muskrat, and swamp rose, wetlands are primary habitats. For others, wetlands provide important seasonal habitats where food, water, and cover are plentiful. Wetlands often function like natural tubs or sponges, storing water (floodwater, or surface water that collects in isolated depressions) and slowly releasing it. Trees and other wetland vegetation help slow floodwaters. This combined action, storage and slowing, can lower flood heights and reduce water's erosive potential. Wetlands reduce the likelihood of flood damage to crops in agricultural areas, help control increases in the rate and volume of runoff in urban areas and buffer shorelines against erosion. Wetlands help improve water quality, including drinking water, by intercepting surface runoff and removing or retaining its nutrients, processing organic wastes and reducing sediment before it reaches open water. Wetlands also provide opportunities for popular activities such as hiking, fishing, and birding.

Of Indiana's estimated original 5,600,000 acres of wetlands, circa 1780, only 750,633 acres were estimated to exist as of the 1980's, a net loss of 87%. Figure 2.2 illustrates the distribution of wetlands per county throughout the state. Indiana has 66 rare wetland-dependent species, such as the Indiana bat. Of these rare species, 58 are animals and eight are plants. National Wetlands Inventory (NWI) maps are available for review from the FWS. A copy of the NWI map of the watersheds in included in Attachment 2.1.5.

The NWI identifies and characterizes potential wetland areas. NWIs are based on high altitude infrared aerial photography. These maps often do not show small wetland areas (less than three acres). Additionally, few of the wetland areas on the NWI maps are field verified. NWI maps classify wetlands based on themes developed specifically for the NWI project. Wetlands identified on the maps are classified by System, Class, and Water Regime. Wetland classifications are mapped by using codes that are abbreviations classification types. Definitions of wetland codes that occur within the watersheds are included in Attachment 2.1.5a and Appendix A.

2.1.6 Hydric Soils

Hydric soils are defined as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Nearly all hydric soils exhibit characteristic forms that result from repeated periods of saturation and/or inundation for more than a few days. Saturation or inundation when combined with ***anaerobic*** microbiological activity in the soil causes a depletion of oxygen. This anaerobiosis promotes ***biogeochemical*** processes such as the accumulation of organic matter and the reduction, translocation, and/or accumulation of iron and other reducible elements. These processes result in characteristic forms that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils.

Anaerobic – an oxygen-free environment
Biogeochemical – nutrient cycling in the soil

Hydric soils within the watersheds are mapped due to their potential to support wetland restoration or construction. For the purposes of this report, general soil associations exhibiting predominately hydric characteristics have been mapped. A copy of the Hydric Soils Map is included in Attachment 2:1.6. A copy of the hydric soils list for Union County, Indiana, is included in Appendix B.

2.1.7 Floodplain

Flood Hazard Boundary Maps (FHBMs) of Union County were available for review from the United States Department of Housing and Urban Development. Using the FHBMs, the 100 year flood hazard zones within the watersheds were mapped. The term "100-year flood" is often incorrectly used and can be misleading. It does not mean that only one 100-year magnitude flood will occur every 100 years. The term is a statement of probability that scientists and engineers use to describe how one flood compares to others that are likely to occur. Today, we use the phrase "1% annual chance flood." It means that there is a 1% chance of a flood of that size happening in any year. Over a 100-year period, it has a 63.5% chance of occurring. Even more surprising is that over a 30-year period (typical mortgage period) the 1% annual chance flood has a 26% chance of occurring. A copy of the Floodplain Map has been included in Attachment 2.1.7.

ATTACHMENTS

2.1.1. Land use map
2.1.2. General soil map
2.1.3. Highly erodible land map
2.1.4. Erosion potential map
2.1.5. National Wetlands Inventory map
2.1.5a. National Wetlands Inventory map legend
2.1.6. Hydric soils map
2.1.7. Floodplain map

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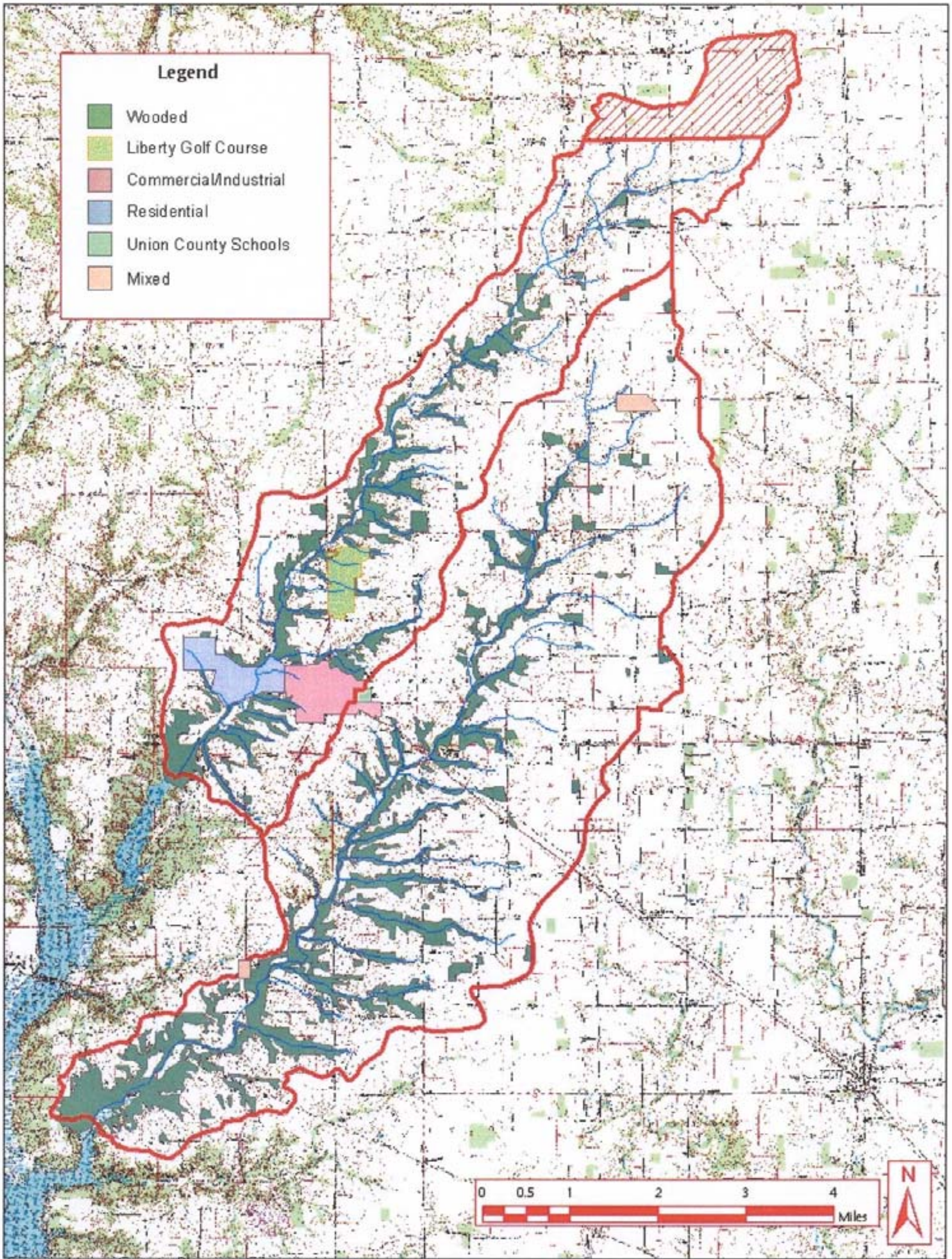
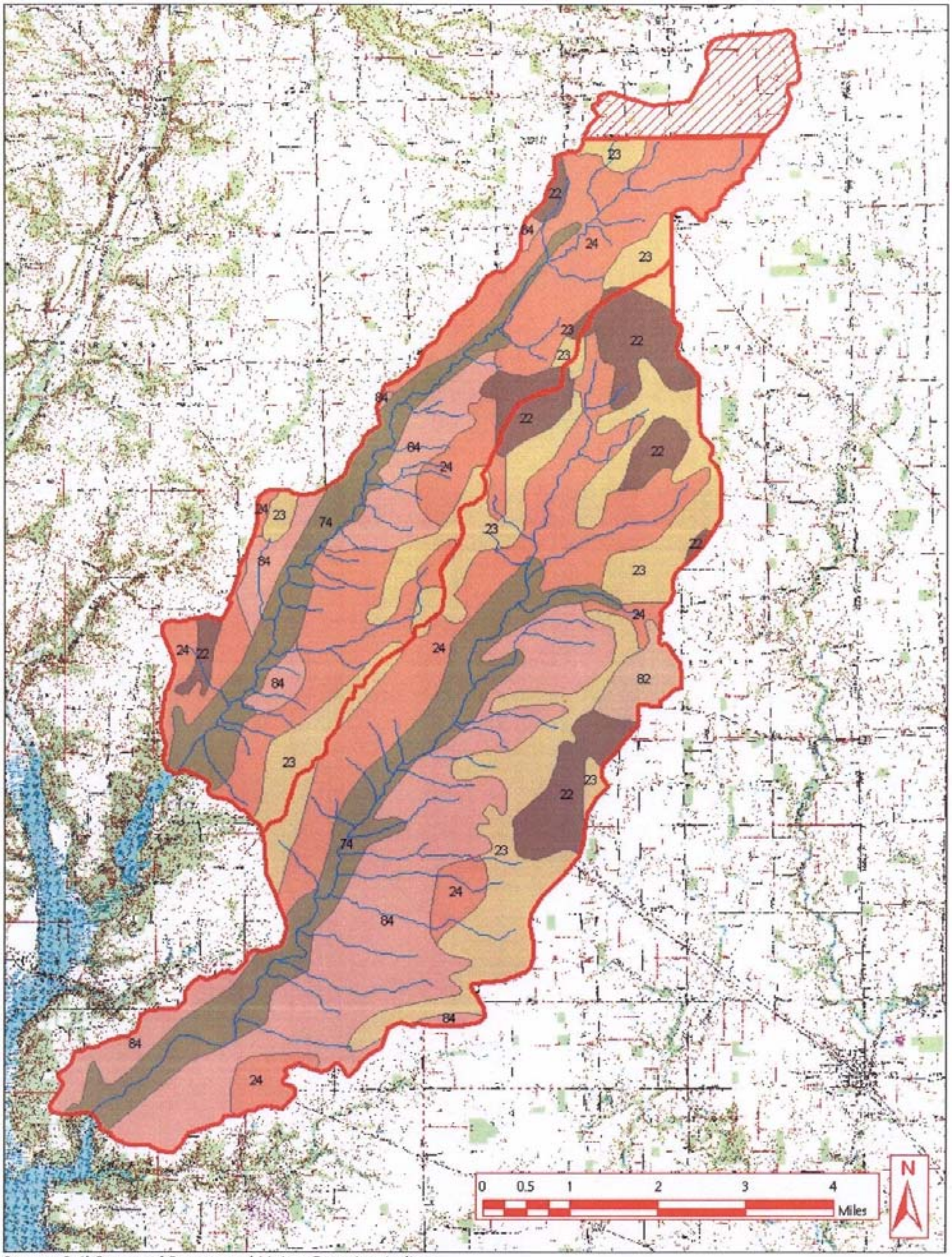
Attachment 2.1.1. Land use map



Source: Union County Planning Commission

Attachment 2.1.2. General soil types



Source: Soil Survey of Fayette and Union Counties, Indiana

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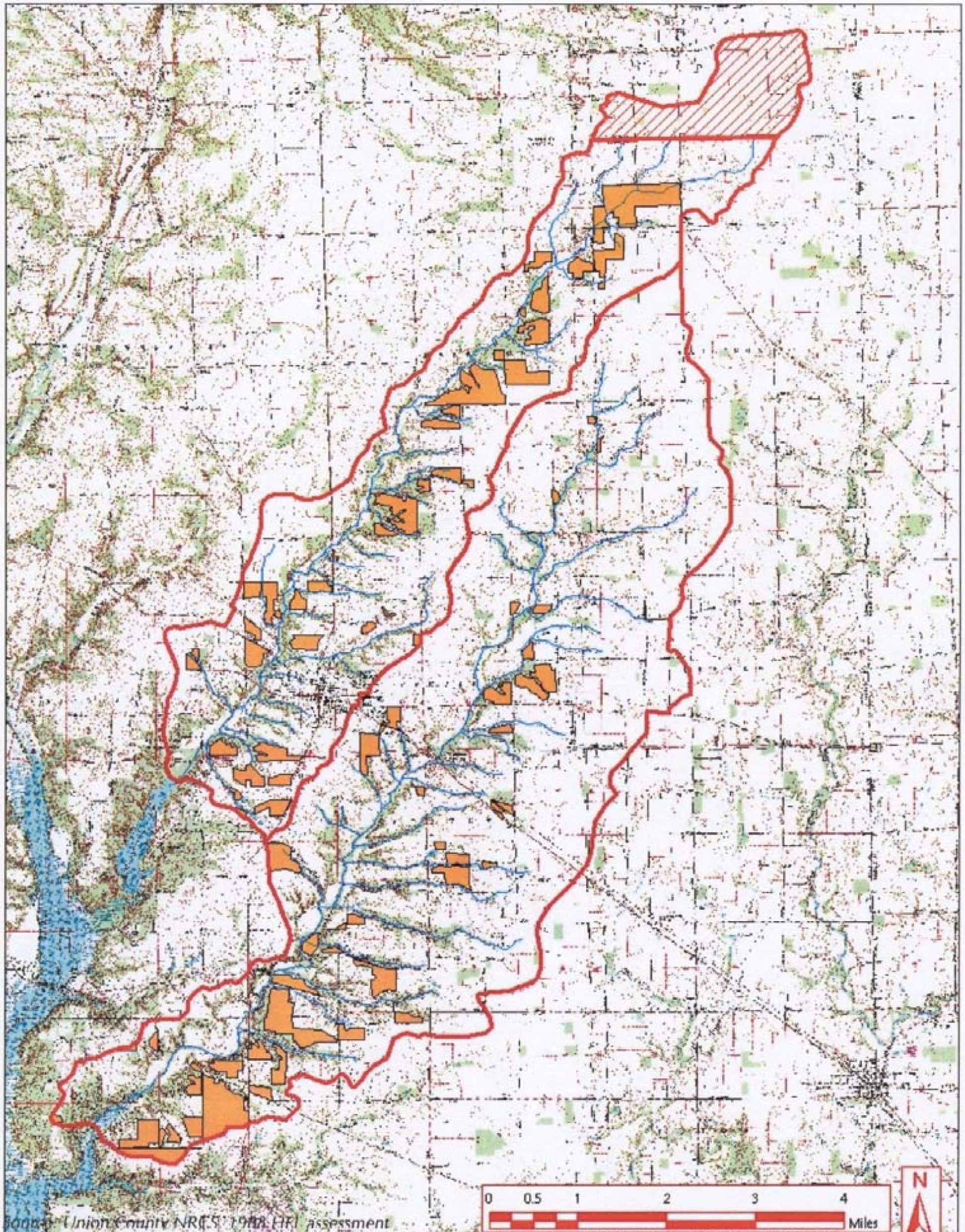
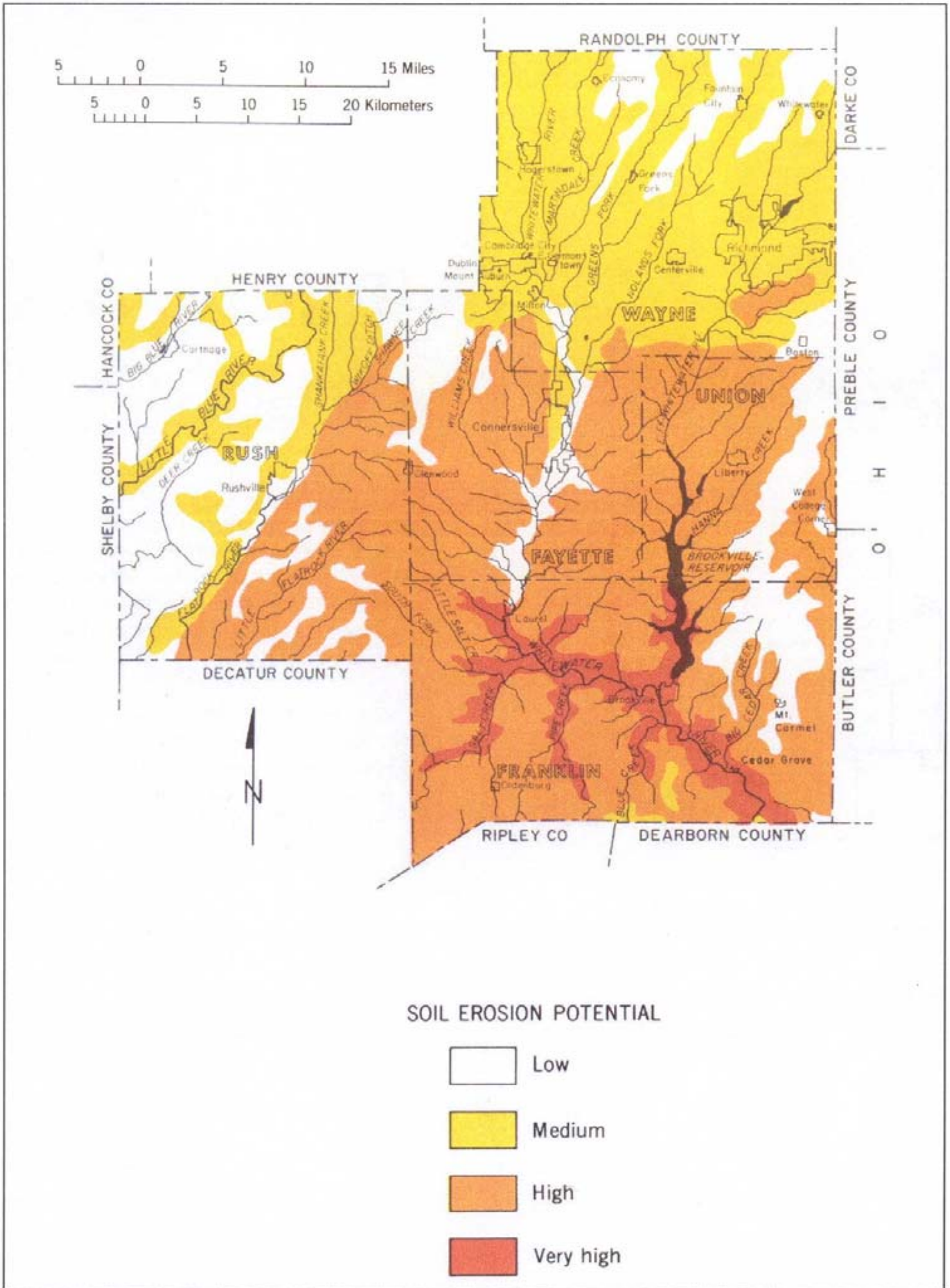
Attahment 2.1.3. Highly erodible land map

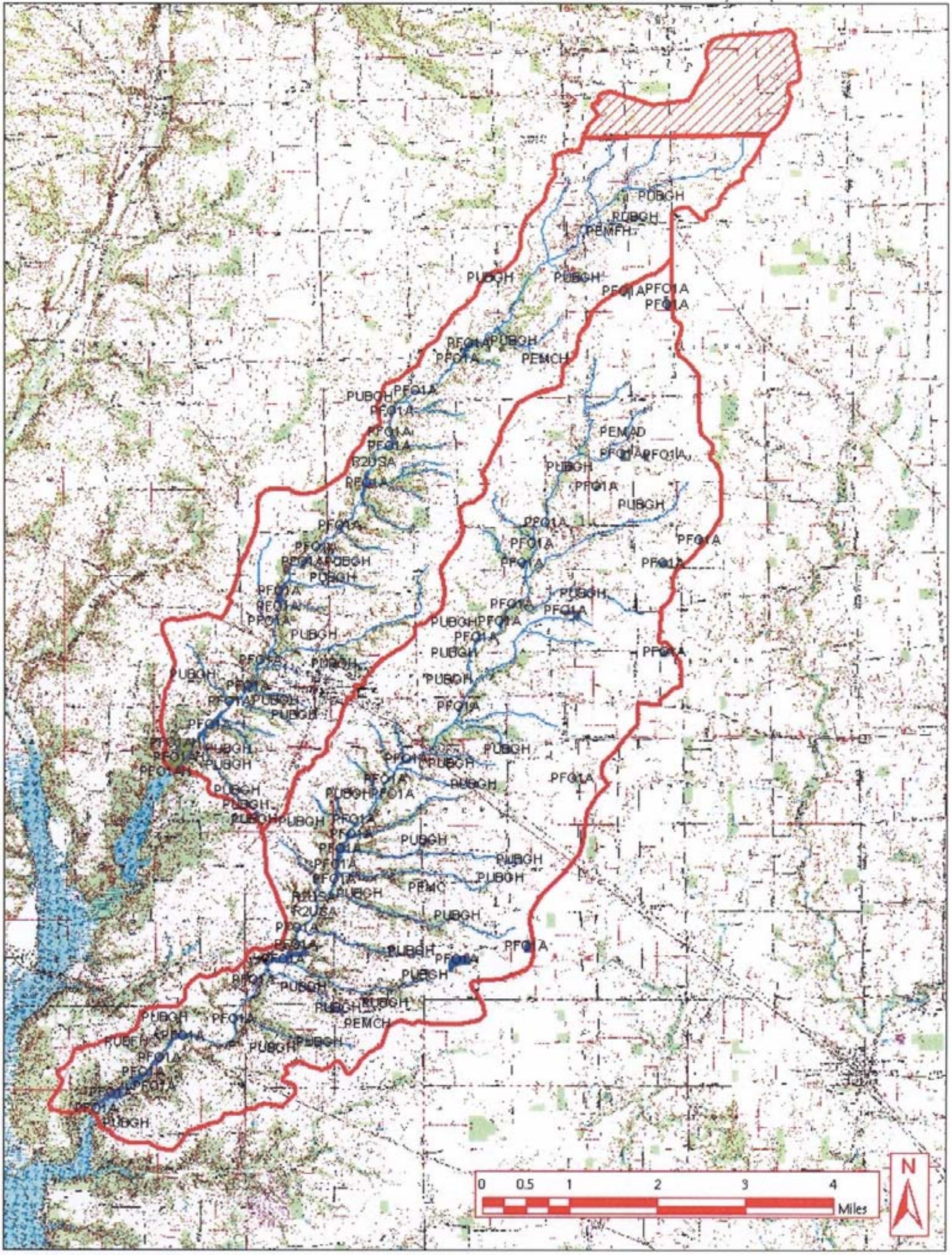


Attachment 2.1.4. Erosion potential map



Source: Indiana Water Resource

Attachment 2.1.5. National Wetlands Inventory Map



Source: United States Fish and Wildlife Service

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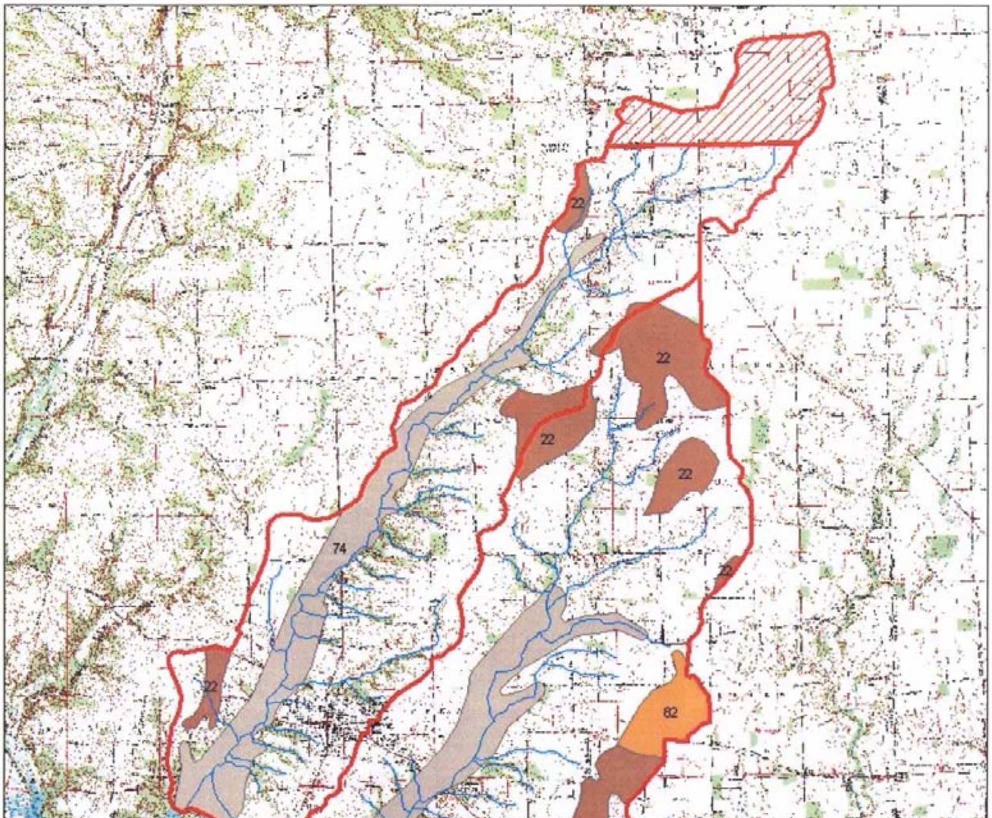
Attachment 2.1.5a National Wetlands Inventory Map Legend

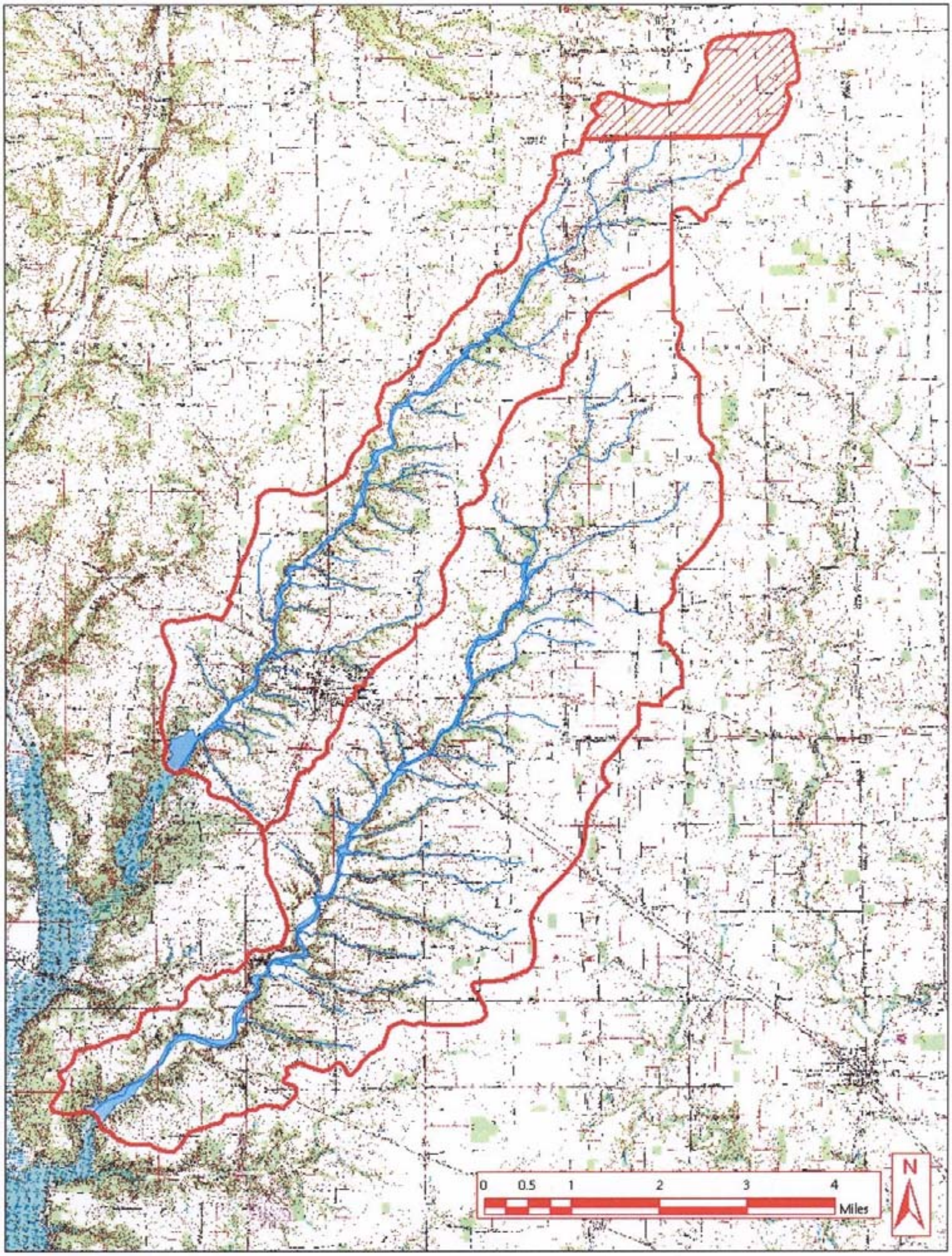
Map Symbol	*Definition*
PEMAD	Palustrine, Emergent, Temporarily Flooded to Seasonally Flooded/ Well Drained
PEMAH	Palustrine, Emergent, Temporarily Flooded to Permanently Flooded
PEMC	Palustrine, Emergent, Seasonally Flooded
PEMCH	Palustrine, Emergent, Seasonally Flooded to Permanently Flooded
PEMFH	Palustrine, Emergent, Semipermanently to Permanently Flooded
PFO1A	Palustrine, Forested, Broad Leafed Deciduous, Temporarily Flooded
PFO1AH	Palustrine, Forested, Broad Leafed Deciduous, Temporarily Flooded to Permanently Flooded
PUBGH	Palustrine, Unconolidated Bottom, Intermittently Exposed to Permanently Flooded
R2USA	Riverine, Lower Perrenial, Unconsolidated Shore, Temporarily Flooded

Attachment 2.1.6. Hydric soils map



Source: Soil Survey of Fayette and Union Counties, Indiana

Attachment 2.1.7. 100 year floodplain boundaries



Source: Federal Emergency Management Agency

2.2 BIOLOGICAL RESOURCES REVIEW

Due to the potential application of the National Environmental Policy Act (NEPA) to any ground-disturbing activities that may be recommended as a result of this study, NEPA evaluation parameters were reviewed.

2.2.1 Designated Wildlife Preserves

There are no designated wildlife preserves within either watershed. According to the national map of wildlife refuges map of Indiana, there are two designated wildlife refuges (Muscatatuck National Wildlife Refuge in Jennings, Jackson, and Monroe Counties and the Patoka River National Wildlife Refuge in Pike and Greene Counties) and two proposed wildlife refuges (Grand Kankakee National Wildlife Refuge in northwestern Indiana and Big Oaks National Wildlife Refuge in Jefferson County) in Indiana. A copy of the Indiana portion of the National Wildlife Refuges map is included in Attachment 2.2.1.

2.2.2 Designated Wilderness Areas

There are no designated wilderness areas within either watershed. According to the National Wilderness Preservation System map of Indiana, the only designated wilderness area in Indiana is the Charles C. Deam Wilderness Area in Monroe County. A copy of the National Wilderness Preservation System map of Indiana wilderness areas is included in Attachment 2.2.2.

2.2.3 Federally Listed Critical Habitats

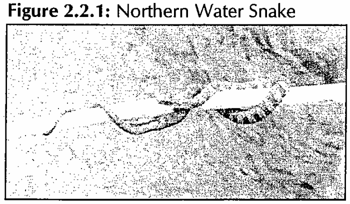
Per Chapter 50 of the Code of Federal Regulations, Parts 17.95 and 17.96, there are no federally listed critical habitats within either watershed.

2.2.4 Habitat

A majority of viable terrestrial habitat within the watersheds is focused along the ***riparian corridors***. According to *The Indiana Water Resource* (IDNR), riparian habitat values range from low to high near the discharge point of each watershed. Hardwoods line the streambanks that are used by upland game, furbearers, and birds commonly found in the area. Recent discoveries of colonies of the federally endangered Indiana bat in Wayne and Rush Counties indicate the importance of riparian habitat. Significant wetland areas are limited to the northern end of Whitewater Lake. A copy of the Riparian Habitat Value map is included in Attachment 2.2.3.

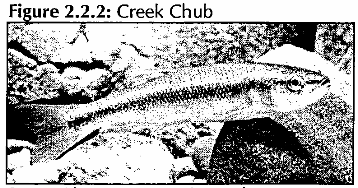
riparian corridors – communities of plants and animals established along waterways

Figure 2.2.1: Northern Water Snake



Photograph location – Sample Location 2

Figure 2.2.2: Creek Chub



Source: Ohio Department of Natural Resources

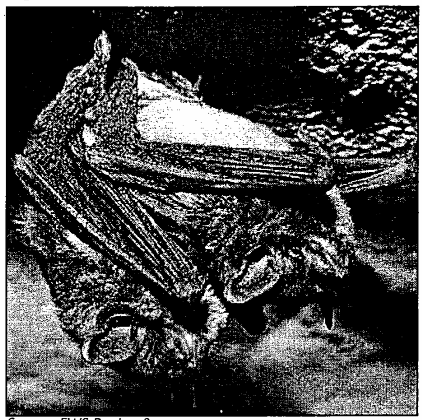
In general, the Whitewater River watershed has good aquatic habitat. Various stretches of streams and tributaries have been more adversely affected by agricultural practices and urban land uses and, therefore, have lower quality aquatic habitat. Fish advisories have indicated the potential of mercury contamination in the creek chub (*Semotilus atromaculatus*) in Silver Creek (Figure 2.2.2). A copy of the Aquatic Habitat Value map is included in Attachment 2.2.4.

2.2.5 Protected Species

Data requests were submitted to the United States Department of the Interior, Fish and Wildlife Service (FWS) and the Indiana Department of Natural Resources (IDNR), Division of Nature Preserves (DNP) concerning protected species within the watersheds. Known occurrences or discoveries of these species within the watersheds may require specialized planning during subsequent watershed improvement projects. According to the FWS, the range of the Indiana bat *(Myotis sodalis)*, a federally endangered species, and the bald eagle *(Haliaeetus leucocephalus)*, a federally threatened species, is statewide. According to the DNP, there are known occurrences of the redside dace (*Clinostomus elongates*), a State of Indiana endangered species, in the Hanna's Creek watershed. Copies of the FWS and DNP correspondence are included in Appendix C.

2.2.5.1 Indiana Bat

Figure 2.2.3: Indiana bat



Source: FWS Region 3

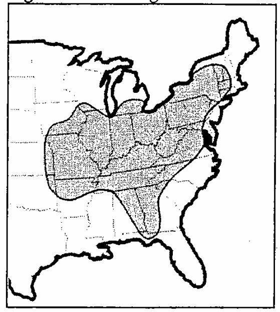
The Indiana bat (*Myotis sodalis*) is a small bat, less than two inches in length, with dark gray to brownish black fur (Figure 2.2.3). Characteristics that help distinguish it from similar species include a pinkish nose, small hind feet with sparse, short hairs that do not extend beyond the toes, and a calcar (the spur extending from the ankle) that has a slight keel. Its hair is less glossy in appearance than that of small brown bats.

The Indiana bat occurs in the Midwest and eastern United States from the western edge of the Ozark region in Oklahoma, to southern Wisconsin, east to Vermont, and as far south as northern Florida (Figure 2.2.4). In summer, it is absent south of Tennessee; in winter, it is apparently absent from Michigan, Ohio, and northern Indiana, where suitable caves and mines are unknown.

Migration to the wintering caves usually begins in October. Summer records are rather scarce. A few individuals have been found under bridges and in old buildings, and several maternity colonies have been found under loose bark and in the hollows of trees. Summer foraging by females and juveniles is limited to riparian and floodplain areas. Creeks are not used if riparian trees have been removed. Males forage over floodplain ridges and hillside forests and usually roost in caves.

The decline of the Indiana bat is attributed to commercialization of roosting caves, wanton destruction by vandals, disturbances caused by increased numbers of spelunkers and bat banding programs, use of bats as laboratory experimental animals, and possibly insecticide poisoning. Some winter hibernacula have been rendered unsuitable as a result of blocking or impeding airflow into the caves and thereby changing the cave's climate. The Indiana bat is nearly extinct over most of its former range in the northeastern states, and since 1950, the major winter colonies in caves of West Virginia, Indiana, and Illinois have disappeared. During this period approximately 87 percent of the entire population hibernates in only seven caves.

Figure 2.2.4: Range of Indiana bat



Source: FWS Region 3

The original Indiana bat recovery plan was approved in 1976, and a revised plan was approved on October 14, 1983. Some of the major recovery goals include: (1) preserving critical winter habitat by securing primary caves and mines and restricting entry; (2) initiating an information and education program; and, (3) monitoring population levels and habitat (to include an evaluation of pesticide affects). To date, the primary conservation efforts have been to control access by the installation of properly designed gates across cave entrances.

2.2.5.2 Bald Eagle

The bald eagle *(Haliaeetus leucocephalus)* was initially listed on February 14, 1978, as a federally protected species throughout the lower 48 states. On July 12, 1995, the FWS announced that the bald eagle would be reclassified from endangered to threatened in the lower 48 states, effective August 11, 1995. In those states where the species was already listed as threatened, it remains so classified.

Figure 2.2.5: Bald eagle

The bald eagle is a large raptor. The characteristic adult plumage consists of a white head and tail with a dark brown body (Figure 2.2.5). Juvenile eagles are completely dark brown and do not fully develop the majestic white head and tail until the fifth or sixth year. Fish are their primary food source but bald eagles will also take a variety of birds, mammals, and turtles (both live and as ***carrion***) when fish are not

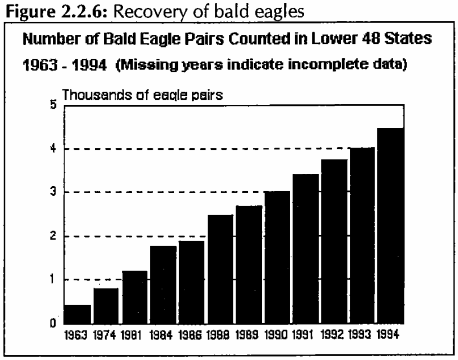
Carrion – animal carcass in an advanced state of decomposition

readily available. Adults average about three feet from head to tail, weigh approximately 10 to 12 pounds and have a wingspread that can reach seven feet. Generally, female bald eagles are slightly larger than males.

Breeding pairs of bald eagles unite for life or until the death of their mate. The breeding season varies throughout the U.S., but typically begins in the winter for the southern populations and progressively shifts toward spring the further north the populations occur. The typical nest is constructed of large sticks and lined with soft materials such as pine needles and grasses. The nests are very large, measuring up to six feet across and weighing hundreds of pounds. Many nests are believed to be used by the same pair of eagles year after year. Female eagles lay an average of two eggs; however, the clutch size may vary from one to three eggs. The eggs are incubated about 35 days. The young fledge nine to 14 weeks after hatching and at approximately four months the young eaglets are on their own.

As Figure 2.2.6 shows, the population of bald eagles in the lower 48 states has certainly increased within the past 31 years. Though the bald eagle has recently been reclassified to threatened, this action does not alter those conservation measures already in effect to protect the species and its habitat. Periodic review of the status of the species will continue through annual surveys and bird banding.

Figure 2.2.6: Recovery of bald eagles

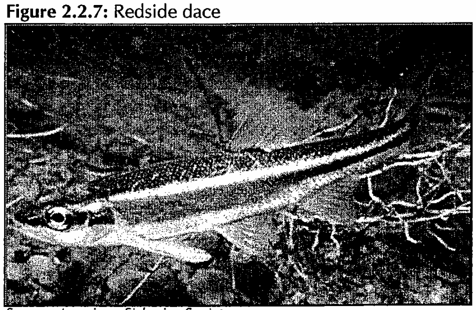


Source: FWS Region 3

2.2.5.3 Redside Dace

According to the DNP, there are known occurrences of the redside dace (*Clinostomus elongates*), a state endangered species, in the Hanna's Creek waterhsed. Minnows of this genus are usually about 3-4 inches long, have a broad, dark band along the lateral line, and have a pointed head with a large mouth (Figure 2.2.7). Typically found in headwater streams, the redside dace tends to avoid both very warm and extremely cold waters. In these small streams it prefers clear pools

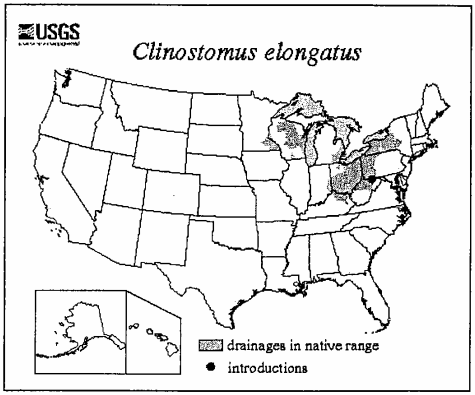
Figure 2.2.7: Redside dace



Source: American Fisheries Society

with stony bottoms. It occurs in schools that actively search for food during daylight hours. Their large mouths enable them to capture flying insects while leaping out of the water. Spawning occurs in late spring. Redside dace are group spawners, frequently depositing their eggs in creek chub nests. There is no parental care given to either the eggs or young.

Figure 2.2.8: *Range of redside dace*



Source: USGS

Redside dace make good environmental indicators of water quality because of their need for clean water. The redside dace is particularly sensitive to riparian habitat degradation. Siltation, removal of natural edge cover, channelization, and pollution from agricultural, domestic, and industrial sources reduce suitable habitat and food sources for this species. A map of the range of the redside dace is included in Figure 2.2.8. The redside dace has been identified in Hanna's Creek (and/or its tributaries) from roughly the Fosdick Road bridge north to Fouts Road, and in Nutter Creek east to Stone Road. These occurrences were reported in 1998.

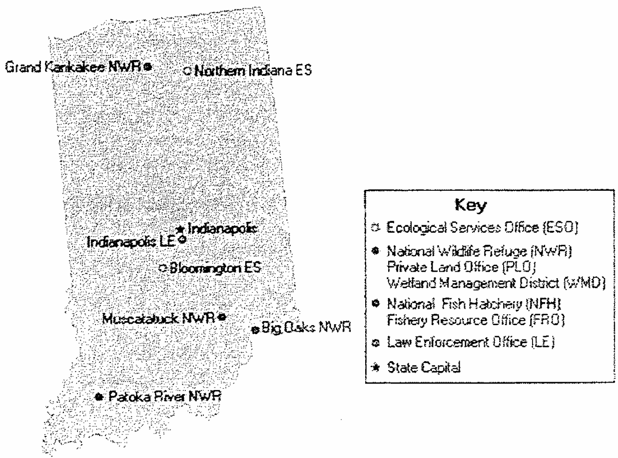
ATTACHMENTS

2.2.1. Designated Wildlife Preserves map
2.2.2. Designated Wilderness Areas map
2.2.3. Riparian Habitat Value map
2.2.4. Aquatic Habitat Value map

Attachment 2.2.1. Designated Wildlife Preserves map

U.S. Fish & Wildlife Service

Indiana



Click here to download/view the entire 2001 Indiana State Fact Book **in .PDF format (File size: 1.2 MB)**

Links to Offices and Services in Indiana

National Wildlife Refuges	
Big Oaks National Wildlife Refuge	812-273-0783
Grand Kankakee National Wildlife Refuge	
Muscatatuck National Wildlife Refuge	812-522-4352
Patoka River National Wildlife Refuge	812-749-3199

Source: United States Fish and Wildlife Service

Attachment 2.2.2. Designated Wilderness Areas map

National Wilderness Preservation System

Indiana

Fast Facts for Indiana	
Total Wilderness acres:	12,945
Total number of areas:	1
Largest Wilderness:	Charles C. Deam
Smallest Wilderness:	Charles C. Deam
Managing Agency(s):	FS

Click a wilderness area on the map above to learn more.

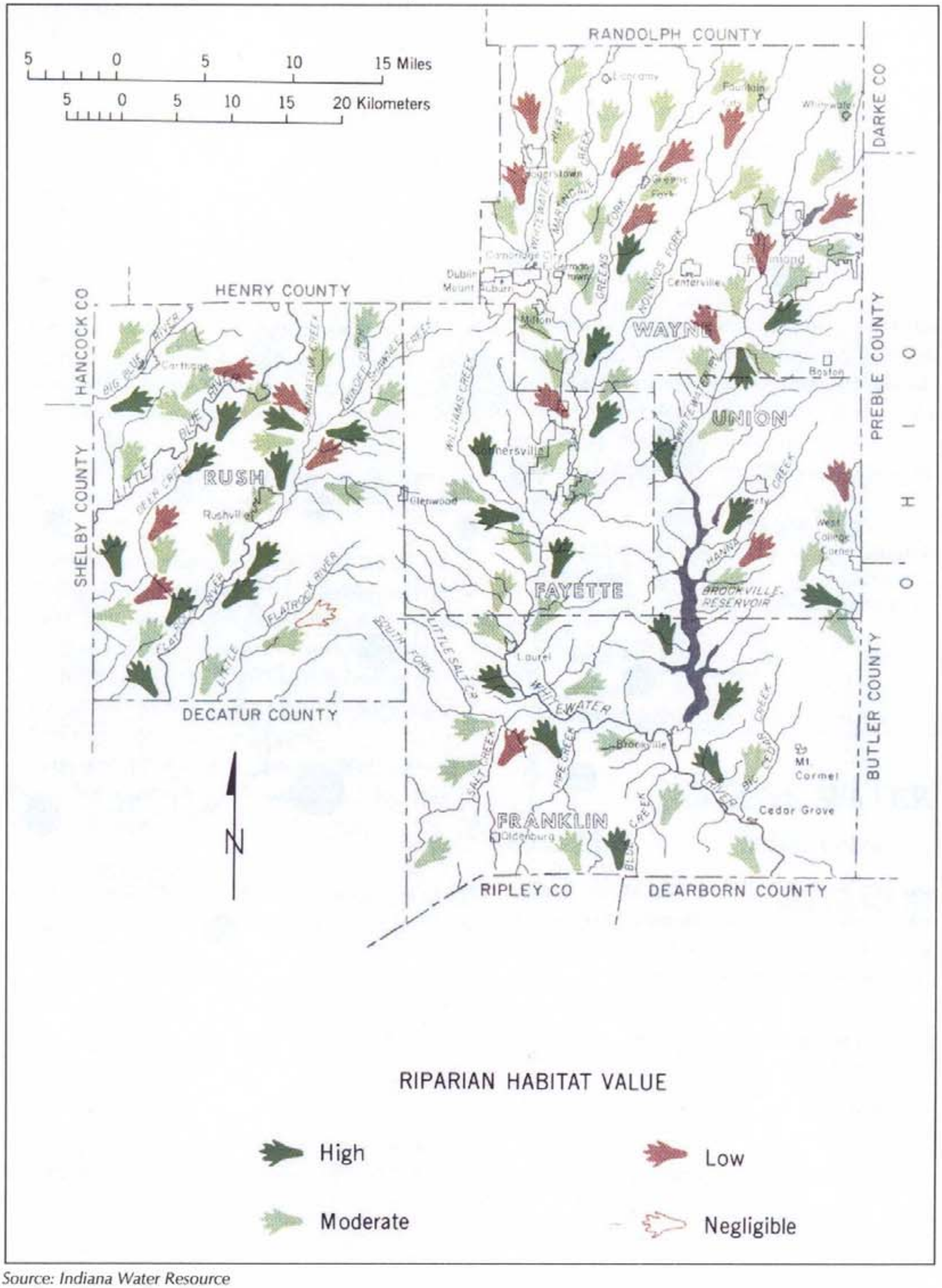
Wilderness Search Engine
Advanced Wilderness Search Engine

View map legend | Send this page to a friend

learn about wilderness | wilderness map | wilderness area search | home

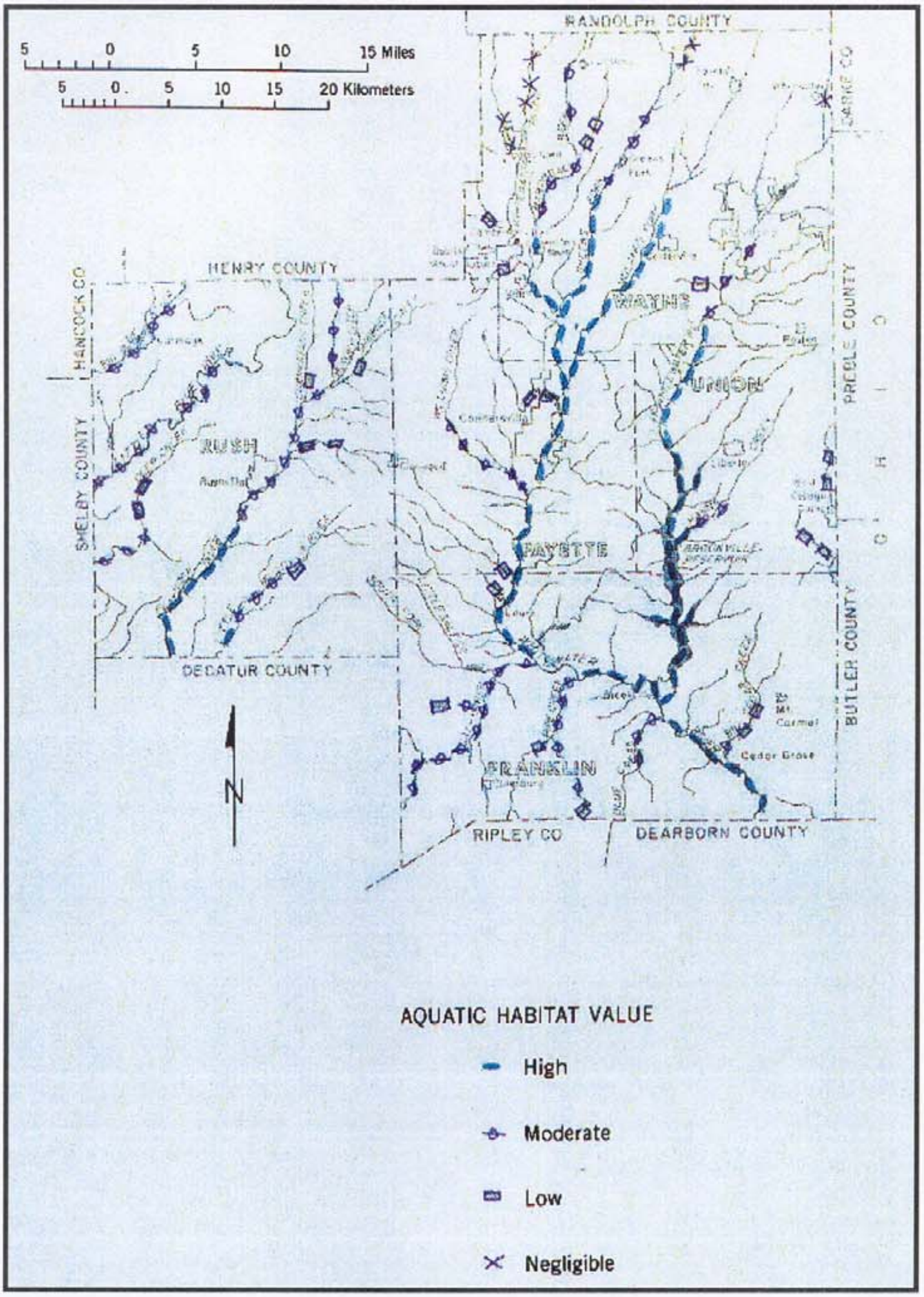
Source: United States Department of the Interior

Attachment 2.2.3. Riparian Habitat Value map



Source: Indiana Water Resource

Attachment 2.2.4. Aquatic Habitat Value map



Source: Indiana Water Resource

2.3 CULTURAL RESOURCES REVIEW

2.3.1 History

Union County was formed in 1812 from parts of Wayne, Franklin, and Fayette counties. Earlier it was part of Dearborn County. Most of the land in Union County was ceded to the United States by the Miami Confederacy of Indians in the Treaty of Greenville only a few years before it was settled. The remainder of the county was ceded by the Indians in the "Twelve Mile" Purchase of 1809 at Fort Wayne.

When the first settlers came to Union County, Indians were living west of the Whitewater River near Paddock's Ford. Indians hunted near settlers' homes and were usually friendly and helpful. Colonists built Fort Dunlap about one mile west of Dunlapsville, a stockade southwest of Richland Cemetery, and a block house along the Harrison-Center Township line about one mile west of the CSX railroad; however, no record of battles or massacres can be found in these areas. Much earlier, Union County had been the home of people known as "Mound Builders", probably of the Hopewell Indian culture group. About ten mounds have been observed in Union County.

Beginning in 1804, Union County was settled rapidly by two streams of people, one from the Carolinas, a second from Pennsylvania and New Jersey. Smaller numbers came from Virginia, Tennessee and other states. Surprisingly, few early settlers came from Ohio or Kentucky.

The name of the county may have been suggested by the method of formation or by the name of Union, the earliest town in the area, or by both. Union, established before 1810, stood on the east bank of Hanna's Creek along a road now abandoned. Brownsville was selected as the first county seat of Union County, it was the largest town in the new county, platted in 1815. Residents of the eastern part of the county insisted on a more central location. Liberty became the new county seat in 1823.

2.3.2 Demographics

According to the United States Census Bureau, the population of Union county is 7,349 (2000), which is an overall increase of 8.9% since 1900. Union County population data is included in Table 2.3.1. From 1985 to 1990, there was a net increase of population of 348 persons over the age of five who migrated to, versus emigrated from, Union County. From 1998 to 1999, there was a net migration increase of 42 persons and a natural increase (births minus deaths) of 24. This appears to reveal a trend toward growth in Union County; however, the projected population in 2020 is 7,329, a decrease of less than 0.01%. This decrease is likely due to the "baby boomer" phenomenon. The negative growth population age structure is due to the large number of persons over the age of 65 (949) versus the number of persons below the age of four (514). The effects of this population paradigm will likely be temporary. The average annual growth rate in the United States is less than 1%; therefore, long-term growth is projected to be steady, yet slow, in Union County. Demographic data sources are included in Appendix D.

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Table 2.3.1: Historic and projected county population of Union County

Year	***1900***	***1910***	***1920***	***1930***	***1940***	***1950***	***1960***	***1970***	***1980***	***1990***	***2000***	***2020***
Population	6748*	6260*	6021*	5880*	6017*	6412*	6457*	6582*	6860*	6976*	7349*	7329**

** - US Census Bureau; ** - Indiana Business Research Center (projected)*

Union County is predominantly agricultural; however, the amount of land in agricultural production has been steadily decreasing from approximately 98.4% in 1900 to approximately 79.8% in 1997, a reduction of approximately 18.9%. Farm earnings in Union County accounted for 20% of the total earnings, compared with 23% from government and 21% from wholesale-retail trade. Information detailing agricultural history is included in Table 2.3.2.

Table 2.3.2: Farm land use history of Union County (in acres)

Year	***Land in Farms***	***Harvested Cropland***	***Land Pastured***	***Woodland Not Pastured***
1900	101,710	n/a	n/a	n/a
1910	102,182	n/a	n/a	n/a
1920	100,269	n/a	n/a	n/a
1930	102,571	57,910	35,113	2,246
1940	100,192	50,252	n/a	n/a
1950	98,646	55,311	31,287	3,867
1959	98,514	56,656	n/a	4,771
1964	93,400	51,621	n/a	4,340
1969	94,673	48,667	n/a	n/a
1974	87,992	57, 148	n/a	n/a
1978	86,718	61,293	13,791	5,210
1982	87,721	63,491	11,609	6,165
1987	87,958	56,104	9,607	5,657
1992	80,069	60,422	9,265	4,987
1997	82,500	63,111	8,716	5,393

n/a – not available
Source: US Census of Agriculture (February 1989)

With an increase in population and a decrease in agricultural properties, it appears that Union County is slowly shifting from an agricultural base to a more urban base. Twenty-eight percent of the county's population lives within Liberty. A majority of the population increase has occurred within Liberty. Watershed management planning should consider the effects of the growing urban landscape within the watersheds.

2.3.3 Archaeological Records Review

An archaeological records review was performed for the Silver Creek and Hanna's Creek watersheds. There are 40 known archaeological sites within the watersheds. Of these, 11 have been deemed "not eligible" for listing on the National Register of Historic Places. The eligibility of the remaining 29 sites is uncertain. The full archaeological report is included in Appendix E.

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2.4 GOVERNMENT RECORDS REVIEW

This section includes information provided by the United States Environmental Protection Agency (USEPA), the Indiana Department of Environmental Management (IDEM), and other state and local regulatory agencies. These records are reviewed to identify facilities or environmental conditions that may impact the watersheds. A portion of the information included in this section was compiled by EcoSearch Environmental Resources, Inc. (EcoSearch). The EcoSearch Government Records Search, including site maps, is included in Appendix F (Hanna's Creek) and Appendix G (Silver Creek).

2.4.1 National Priorities List (NPL)

The NPL identifies uncontrolled hazardous waste sites that warrant further investigation to determine if long-term "remedial action" is necessary. The NPL is comprised of two sections, the Federal Section and the General Section. The sites in the General Superfund Section of the NPL are eligible for remedial action funded under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), enacted on December 11, 1980, and amended by the Superfund Amendments and Reauthorization Act. According to this database, there are no NPL sites within the watersheds.

2.4.2 Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

The CERCLIS is an inventory of all potential uncontrolled hazardous waste sites, based upon state and federal investigation efforts, and notifications received as provided by CERCLA. There are no CERCLIS sites within the watersheds.

2.4.3 Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities

The USEPA publishes a list of all hazardous waste TSD facilities in Indiana. According to this list, there are no TSD facilities within the watersheds.

2.4.4 Hazardous Waste Handlers

The USEPA Hazardous Waste Handlers List provides information on all companies that have been assigned a USEPA identification number. These numbers are assigned to large quantity generators (LQG, generates more than 2,200 pounds per month), small quantity generators (SQG, generates 220 to 2,200 pounds per month), and transporters. Conditionally exempt generators (generates less than 220 pounds per month) are not required to obtain a USEPA identification number. There are three facilities within the Silver Creek watershed and one within the Hanna's Creek watershed. Information detailing these facilities is included in Table 2.4.1.

Table 2.4.1: *Hazardous Waste Handlers data*

Watershed	*Facility*	*Address*	*Type*
Silver Creek	D&L Industrial Finishes, Inc.	215 Brownsville	LQG
Silver Creek	Hofmann Body Shop	1735 US 27 North	SQG
Silver Creek	Kirk Nationalease	186 Kitchel Road	SQG
Hanna's Creek	Kaiser Agricultural Chemicals	Route 3	SQG

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2.4.5 Resource Conservation and Recovery Information System-Corrective Action Sites (CORRACTS)

The CORRACTS database includes Resource Conservation and Recovery Information System sites with reported corrective action. There are no CORRACTS, within one mile of the site.

2.4.6 Emergency Response Notification System (ERNS)

ERNS is a national database which contains information on specific notification of releases of oil and hazardous substances into the environment. According to this list, there has been one ERNS incident within the Hanna's Creek watershed:

> September 15, 1998 – 230 gallons of anhydrous ammonia were released into the atmosphere when a valve failed on a nurse tank. The release occurred at the Union County Farm Coop at 2469 South Highway 27 in Liberty. No other information was available for this incident.

2.4.7 Permit Compliance System (PCS)

The PCS database details permitted discharge information from the National Pollutant Discharge Elimination System. According to this database, there is one PCS facility within the Silver Creek watershed. Information detailing this site is included in Table 2.4.2.

Table 2.4.2: PCS site data

Watershed	*Facility*	*Address*	*Type*
Silver Creek	Liberty Municipal WWTP	SR 44 & Dewey St	wastewaster treatment

See Recommendations and Conclusions

2.4.8 IDEM State Cleanup List (SCL)

This database identifies sites deemed by the State of Indiana for remediation. The database identifies sites participating in various programs such as the IDEM's State Cleanup, Voluntary Remediation Program, Immediate Removal Sites, and Defense Environmental Restoration Program sites. There are no SCL sites located within the watersheds.

2.4.9 Solid Waste Facilities (SWFs)

According to the IDEM list of Permitted Solid Waste Facilities, there are two solid waste facilities within the Silver Creek watershed. Information detailing these sites is included in Table 2.4.3.

Table 2.4.3: Solid Waste Facilities data

Watershed	*Facility*	*Address*	*Type*
Silver Creek	Union County Transfer Station	CR 100 E	county transfer station
Silver Creek	Union County Landfill	CR 100 E & CR 200 N	private landfill

2.4.10 Underground Storage Tanks (USTs)

The IDEM maintains files for all registered USTs in Indiana. According to this database, there are 18 registered facilities within the watersheds. Information detailing these facilities is included in Table 2.4.5.

Table 2.4.5: UST facility data

Watershed	*Facility/Address*	*No. – Size (gal.)*	*Status*

Silver Creek	Frame's, R.R. 1	2 – not reported	not reported
Silver Creek	Frame's R.R. 2, Box 202A	2 – 1,000	permanently out of service
Silver Creek	FID 009473 3 North Railroad Street	1 – not reported	not reported
Silver Creek	Liberty Oil Co. 3 North Railroad Street	1 – 1,000 2 – 3,000 1 – 4,000 1 – 5,000 4 – 6,000	closed 2/15/87 closed 2/15/87 closed 2/15/87 closed 2/15/87 closed 2/15/87
Silver Creek	SS #20268 Main and Sycamore	1 – 1,000 3 – 6,000	permanently out of service permanently out of service
Silver Creek	Johnson's Service 206 North Main Street	2 – 3,000 1 – 4,000	closed 11/1/92 closed 11/1/92
Silver Creek	Richardson Sunoco 10 South Main Street	1 – 3,000 1 – 6,000 1 – 8,000	closed 5/31/95 closed 5/31/95 closed 5/31/95
Silver Creek	Liberty Shell 10 North Main Street	1 – 1,000 1 – 8,000 3 – 10,000	currently in use currently in use currently in use
Silver Creek	Scaggs Oil Co. 110 North Main Street	4 – 8,000	currently in use
Silver Creek	Union 76 101 North Main Street	1 – 550 2 – 3,000 2 – 4,000 1 – 10,000 3 – 8,000	closed 5/8/92 closed 3/31/94 closed 3/31/94 closed 11/11/99 currently in use
Silver Creek	Miles-Richmond 221 South Main Street	1 – 10,000	permanently out of service
Silver Creek	Union County Co-op 101 West Campbell	1 – 1,000 2 – 10,000 6 – 10,000 2 – 20,000	closed 2/1/98 closed 2/10/98 currently in use currently in use
Silver Creek	Union County EMT State Road 27	2 – 4,000 1 – 8,000	closed 11/1/98 closed 11/1/98
Silver Creek	Town Garage R.R. 3	1 – 7,000	permanently out of service
Silver Creek	Union County School Corp. 107 Layman Street	1 - 500	closed 8/1/91
Silver Creek	Harold Crouse & Sons R.R. 3 Box 58	1 – 1,000 1 – 6,000	unregulated closed 5/10/98
Hanna's Creek	Union County Co-op 2469 State Road 27	not reported	not reported
Hanna's Creek	Kaiser Ag. Chemicals R.R. 3 Box 186	2 – 1,000 1 – 10,000	permanently out of service permanently out of service

2.4.11 Leaking Underground Storage Tanks (LUST)

The IDEM maintains files for all reported LUSTs in Indiana. There are four reported LUST incidents at three locations within the Silver Creek watershed. Information detailing these incidents is included in Table 2.4.4.

Table 2.4.4: LUST incident data

Watershed	*Facility*	*Address*	*Priority*	*Status*
Silver Creek	Richardson Sunoco	10 S. Main St.	medium	active
Silver Creek	Union 76, Liberty Carter's Service	101 N. Main St.	1. low 2. low	1. discontinued 2. active
Silver Creek	Union Co. Co-op	101 W. Campbell	low	active

2.4.12 Indiana Spill Data

The IDEM maintains records of all reported spills of chemicals, petroleum, or otherwise noxious substances in Indiana. There have been six reported spills within the Silver Creek watershed and one reported spill within the Hanna's Creek watershed:

Silver Creek

May 26, 1989 – An unknown amount of gasoline was spilled into a ditch at the intersection of North Main Street and Brownsville Road. The spill was cleaned up in one day.

May 8, 1991 - A fish kill was reported approximately one mile west of Liberty and north of Highway 44. No other information was available.

February 28, 1996 – An open burn of solid waste in a 55 gallon drum was reported at 10 South Main Street. The material within the drum was contained.

October 13, 1998 – 150 gallons of diesel fuel was spilled at the B & C One Stop & Shop located at 101 North Main Street. The spill was contained and cleaned up.

March 29, 1999 – Five gallons of textile spirits and 1,000 gallons of rainwater from secondary containment were spilled due to equipment failure at D & L Industrial Finishes located at 215 Brownsville Avenue. The spill was contained.

June 16, 1999 – An undetermined amount of an unknown substance was spilled at the Kiel Brothers Oil Company located at 101 North Main Street. The spill was cleaned up.

Hanna's Creek

June 11, 1989 – Five gallons of Treflan was spilled at the Kaiser Estech facility located one-half mile east of Liberty. The spill was contained and five gallons of the spilled product were recovered.

2.4.13 County Spill Data

The Indiana Union County Spills Database, maintained by the Union County Emergency Management Office, contains information about hazardous materials spills in Union County.

Based on this database, there have been four reported spills within the Silver Creek watershed and one reported spill within the Hanna's Creek watershed:

Silver Creek

June 16, 1999 – Fifty gallons of gasoline were spilled during the filling of a UST due to a faulty vent line. The spill occurred at 101 North Main Street. The spill was contained and cleaned up.

November 24, 1999 – A two gallon container full of gasoline dropped from the back of a pickup truck and spilled its contents at the corner of North Fairground and Campbell. No other information was available.

December 2, 1999 – An unknown amount of liquid sorghum leaked from a UST at 217 South Main Street. The spill was contained and cleaned up and the impacted soil was excavated.

March 1, 2000 – 100 Gallons of diesel fuel leaked from a semi truck fuel tank at State Road 27 and Highway 44. The spill was contained and cleaned up and the impacted material was properly disposed.

Hanna's Creek

October 6, 1999 – 15 gallons of used machine coolant spilled while being loaded onto a tanker truck at 1112 East Kitchel Road. The spill was contained and cleaned up.

2.4.14 Indiana Confined Feeding Operations (CFO)

The IDEM maintains records on all permitted CFOs in Indiana. Indiana law defines a confined feeding operation as any livestock operation engaged in the confined feeding of at least 300 cattle, 600 swine, 600 sheep, or 30,000 fowl (chickens, ducks, etc.). The database includes information on the following: number and type of livestock; manure management (MM); livestock buildings, either existing (E) or proposed (P); and, water quality violations (WQ). According to this database, there are four CFOs in the Hanna's Creek watershed. Information detailing these operations is included in Table 2.4.6.

Table 2.4.6. CFO data

Facility	*Address*	*Livestock*	*MM*	*Buildings*	*WQ*	*Status*
Not reported	100 S. & S.R. 101	170 swine	CP	1 P	0	voided
NJJ Farms	Salem & Liberty Pike	1530 swine	SMS, CP, EP	6 E	0	active
Stevens Farms	not reported	1353 swine	SMS, CP	6 E	0	active
Hanna's Creek Pig Farm	SW of Kitchel	1224 swine	CP	5 E, 1 P	0	voided

SMS – Solid Manure System, CP – Concrete Pits, EP – Earthen Pits

2.5 PREVIOUS REPORTS

2.5.1 Federal Reports

Sedimentation in Whitewater Lake, Union County, East-Central Indiana, 1959 - 1988 (USGS) – The USGS studied the impact of sedimentation on Whitewater Lake with data from 1959 through 1988. According to this report, the largest amount of sediment has accumulated in the upper part of the lake where Silver Creek enters. The surface area of the lake was 7,580,000 square feet (174 acres) in 1959 and 6,590,000 square feet (151 acres) in 1988. In 1959, the volume of water in Whitewater Lake was calculated to be 138,000,000 cubic feet; in 1988, the volume was 132,000,000 cubic feet. Six million cubic feet of sediment that accumulated from 1959 to 1988 remained in the lake. An additional 4,350,000 cubic feet of sediment was dredged from the lake during 1978 to 1981 and 1984 to 1988. Therefore, the total sediment accumulation in Whitewater Lake from 1959 to 1988 was 10,350,000 cubic feet. Based on this, the annual rate of sediment accumulation has been 357,000 cubic feet per year. If the sediment loading in Whitewater Lake is not mitigated, the volume of water in the lake in 2017 is estimated to be 88.2% of the 1959 volume, a net loss of 11.8%.

National Eutrophication Survey, Whitewater Lake, Union County, Indiana, 1976 (USEPA) – The USEPA completed a nationwide eutrophication study which included Whitewater lake. Nutrient loading from tributaries was assessed as part of this study. Samples were collected from within the Whitewater Lake and from Silver Creek.

2.5.2 State Reports

Water Resources Availability in the Whitewater River Basin, Indiana, 1988 (INDR, Division of Water) – This document was prepared by the IDNR in compliance with The Water Resource Management Act (I.C. 13-2-6.1) of 1983. This report describes the availability, distribution, quality and use of surface and groundwater in the Whitewater River Basin. The report is intended to provide background hydrologic information for water resources decision-making. A majority of the information used for the watershed diagnostic study contained within this report included stream flow data, climatologic data, and demographic data. Prior to this report, no comprehensive hydrologic studies of the Whitewater River Watershed had been published.

Indiana Water Quality Report 2000 (IDEM, Office of Water Management, Planning and Restoration Branch) – This document was prepared by the IDEM in compliance with Section 305(b) of the federal Water Pollution Control Act (the amended Clean Water Act, 1987) which requires states to prepare and submit to the USEPA a water quality assessment report every two years. This report focused on the Upper Wabash River watershed, the East Fork of the White River watershed, and the Great Miami River watershed. A comprehensive investigation of the condition of water resources (groundwater and surface water) was performed in relation to aquatic life, recreation, and consumption.

Indiana T by 2000, Watershed Soil Loss Transects (Purdue Extension and the Natural Resources Conservation Service) – The dataset for Union County (transect IN01081W.TDA), compiled in 2001, reveals the percent and number of present agricultural fields per crop type with indicated tillage-systems for each previous crop. The data is included in the following tables:

Table 2.1. Corn fields with indicated tillage system for each previous crop

Previous crop total	***Tillage System: percent (number)***							
	No-till	***Ridge-till***	***Mulch-till***	***Reduced-till***	***Conventional***	***Other***	***N/A***	***Unknown***
Corn (21)	5 (1)	5 (1)	5 (1)	81 (17)	0 (0)	5 (1)	0 (0)	0 (0)
Soybeans (57)	21 (12)	5 (3)	0 (0)	32 (18)	42 (24)	0 (0)	0 (0)	0 (0)
Small grain (1)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)	0 (0)	0 (0)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)	0 (0)	0 (0)
All (81)	16 (13)	5 (4)	1 (1)	44 (36)	32 (26)	1 (1)	0 (0)	0 (0)

Table 2.2. Soybean fields with indicated tillage system for each previous crop

Previous crop total	***Tillage System: percent (number)***							
	No-till	***Ridge-till***	***Mulch-till***	***Reduced-till***	***Conventional***	***Other***	***N/A***	***Unknown***
Corn (81)	73 (59)	0 (0)	0 (0)	21 (17)	6 (5)	0 (0)	0 (0)	0 (0)
Soybeans (5)	40 (2)	0 (0)	0 (0)	60 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Small grain (4)	25 (1)	0 (0)	0 (0)	25 (1)	50 (2)	0 (0)	0 (0)	0 (0)
Forage (0)	100 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All (81)	69 (63)	0 (0)	0 (0)	23 (21)	8 (7)	0 (0)	0 (0)	0 (0)

Table 2.3. Small grain fields with indicated tillage system for each previous crop

Previous crop total	***Tillage System: percent (number)***							
	No-till	***Ridge-till***	***Mulch-till***	***Reduced-till***	***Conventional***	***Other***	***N/A***	***Unknown***
Corn (81)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
Soybeans (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (4)	0 (0)
Small grain (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All (81)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (7)	0 (0)

Table 2.4. Forage fields with indicated tillage system for each previous crop

Previous crop total	***Tillage System: percent (number)***							
	No-till	***Ridge-till***	***Mulch-till***	***Reduced-till***	***Conventional***	***Other***	***N/A***	***Unknown***
Corn (81)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Soybeans (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
Small grain (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (2)	0 (0)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (8)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All (81)	0 (0)	0 (0)	0 (0)	0 (0)	8 (7)	0 (0)	100 (11)	0 (0)

Table 2.5. Idle fields with indicated tillage system for each previous crop

Previous crop total	*Tillage System: percent (number)*							
	No-till	*Ridge-till*	*Mulch-till*	*Reduced-till*	*Conventional*	*Other*	*N/A*	*Unknown*
Corn (81)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Soybeans (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Small grain (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (4)	0 (0)
All (81)	0 (0)	0 (0)	0 (0)	0 (0)	8 (7)	0 (0)	100 (5)	0 (0)

Table 2.6. Other fields with indicated tillage system for each previous crop

Previous crop total	*Tillage System: percent (number)*							
	No-till	*Ridge-till*	*Mulch-till*	*Reduced-till*	*Conventional*	*Other*	*N/A*	*Unknown*
Corn (81)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Soybeans (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Small grain (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (1)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All (81)	0 (0)	0 (0)	0 (0)	0 (0)	8 (7)	0 (0)	100 (1)	0 (0)

Table 2.7. Unknown fields with indicated tillage system for each previous crop

Previous crop total	*Tillage System: percent (number)*							
	No-till	*Ridge-till*	*Mulch-till*	*Reduced-till*	*Conventional*	*Other*	*N/A*	*Unknown*
Corn (81)	50 (3)	0 (0)	0 (0)	33 (2)	17 (1)	0 (0)	0 (0)	0 (0)
Soybeans (5)	0 (0)	50 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	50 (1)
Small grain (4)	0 (0)	0 (0)	0 (0)	0 (0)	50 (1)	0 (0)	0 (0)	50 (1)
Forage (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N/A (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All (81)	30 (0)	10 (1)	0 (0)	20 (2)	20 (2)	0 (0)	0 (0)	20 (2)

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2.6 FIELD RECONNAISSANCE

2.6.1 Initial Survey

A "windshield survey" was conducted in January 2001 to familiarize the investigators with the area of investigation. The windshield survey provided an initial view of the sampling points, Silver Creek, Hanna's Creek, and a "lay of the land" within both watersheds. Information regarding physical access to sampling points, specialized equipment requirements, location of feedlots, industrial sites, and general land use was obtained.

Figure 2.6.1: View of Sample Location 2

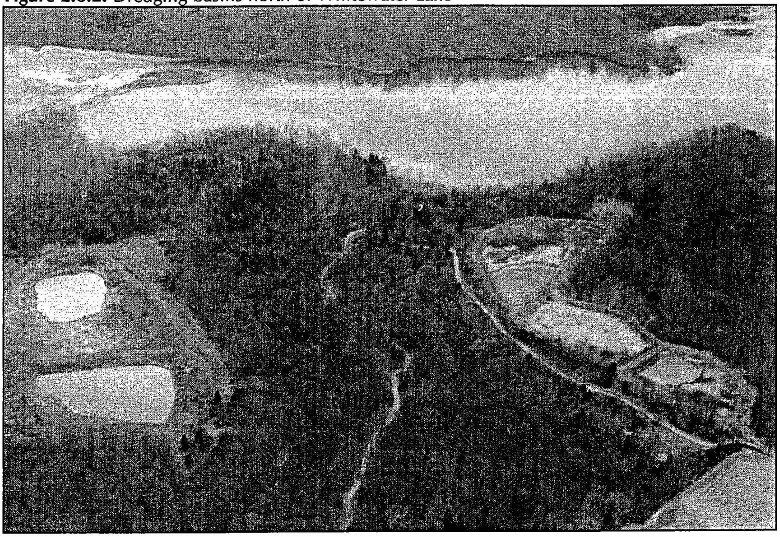
Photographed January 8, 2001

2.6.2 Aerial Flight

An aerial survey was conducted to provide a comprehensive view of the watershed. The aerial survey of the Silver Creek and Hanna's Creek watersheds was conducted on March 27, 2001. Many characteristics of the watersheds are not visible from the ground. It is difficult to observe how these characteristics are interacting with, and impacting each other. An aerial view of the watersheds also provides a view of general landforms and land uses.

Observations made during the aerial flight were photo-documented. Copies of photographs are included. The remains of dredging operations at Whitewater Lake as well as sedimentation at the discharge of Hanna's Creek into Brookville Lake were observed. Agricultural and land use practices that are potentially impacting the watersheds were documented as well.

Figure 2.6.2: Dredging basins north of Whitewater Lake

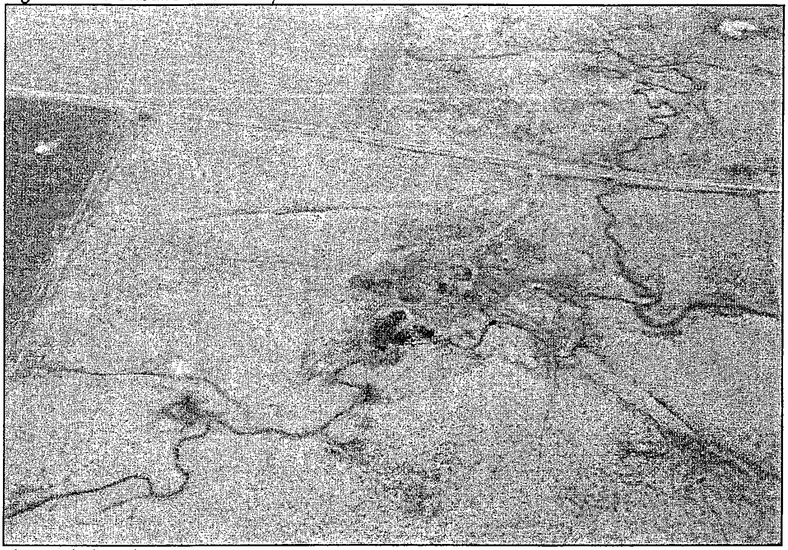


Photographed March 27, 2001

Figure 2.6.3: Livestock operation on tributary of Silver Creek

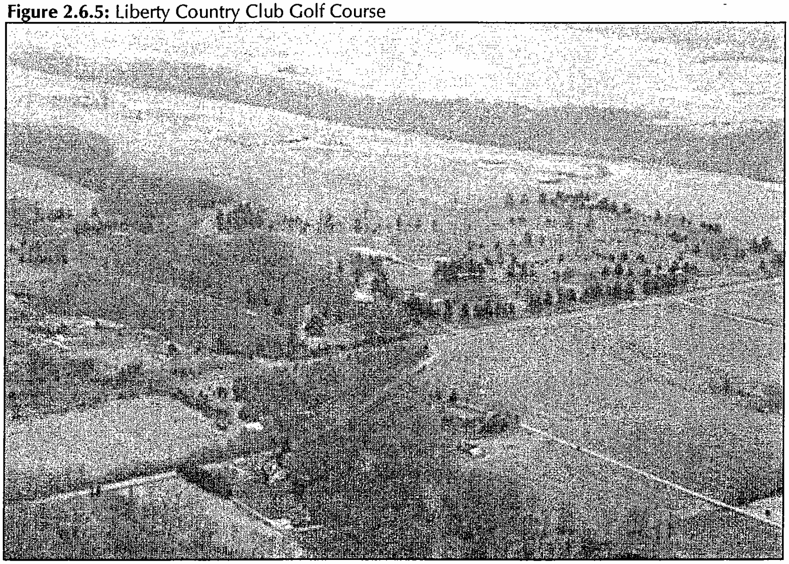
Photographed March 27, 2001

Figure 2.6.4: Unbuffered tributary of Hanna's Creek



Photographed March 27, 2001

Figure 2.6.5: Liberty Country Club Golf Course



Photographed March 27, 2001

2.7 SAMPLE POINT LOCATIONS

2.7.1 Placement Justification

Sampling point locations were established based on potential impact from land use, physical characteristics, ease of access, and property owner approval. Information compiled during the Preliminary Investigation was used to establish sampling locations. A sample location map, including IDEM sample locations, is included in Attachment 2.7.

2.7.2 Description of Locations

Sample locations represent water quality of the Hannah's Creek and Silver Creek drainages with contributions from all upstream tributaries. They are numbered from downstream to upstream. Individual tributaries may have water quality quite different from that found in the cited drainages, as the cited drainage water quality is a result of mixing from all the tributaries. The location of each sample point is as follows:

Hanna's Creek

Sample point 1 is located at the end of Bull Hill Road, west of State Road 101. This sample point is located where Hanna's Creek enters property controlled by the State of Indiana, and is representative of the discharge of Hanna's Creek into Brookville Reservoir.

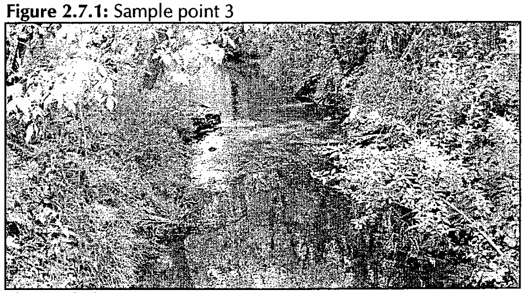
Sample point 2 is located on Retherford Road, east of State Road 101 and Roseburgh.

Sample point 3 is located at the Fosdick Road bridge, immediately east of North Creek Road.

Sample point 4 is located at the Greenwood Road ford, north of State Road 44.

Sample point 5 is located at the Swafford Road bridge, at the intersection of Kitchell Road and Swafford Road. Sampling point 5 represents the headwaters of Hanna's Creek.

Figure 2.7.1: Sample point 3



Photographed May 14, 2001

Silver Creek

Sample point 6 is located on State of Indiana property, at the end of an abandoned county road, south of Snake Hill Road. This sampling point represents the discharge of Silver Creek into Whitewater Lake.

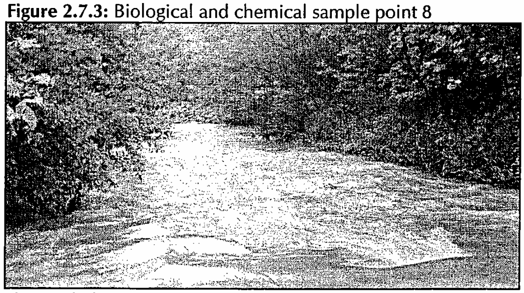
Figure 2.7.2: Sample point 6

Photographed May 14, 2001

Sample point 7 is located at the Snake Hill Bridge, east of County Road 100 West. Tributaries of Silver Creek that contribute to sample point 7 include the Town of Liberty Wastewater Treatment Plant (WWTP) discharge.

Sample point 8 has two locations. The point used for flow monitoring is located at the County Road 200 North bridge, east of U.S. Highway 27. The chemical and biological sampling point was relocated to Troy's property, located west of Old 27 Road. The chemical and biological sampling point was moved to this location, as it is downstream from tributaries that drain the Liberty Country Club golf course.

Figure 2.7.3: Biological and chemical sample point 8



Photographed May 18, 2001

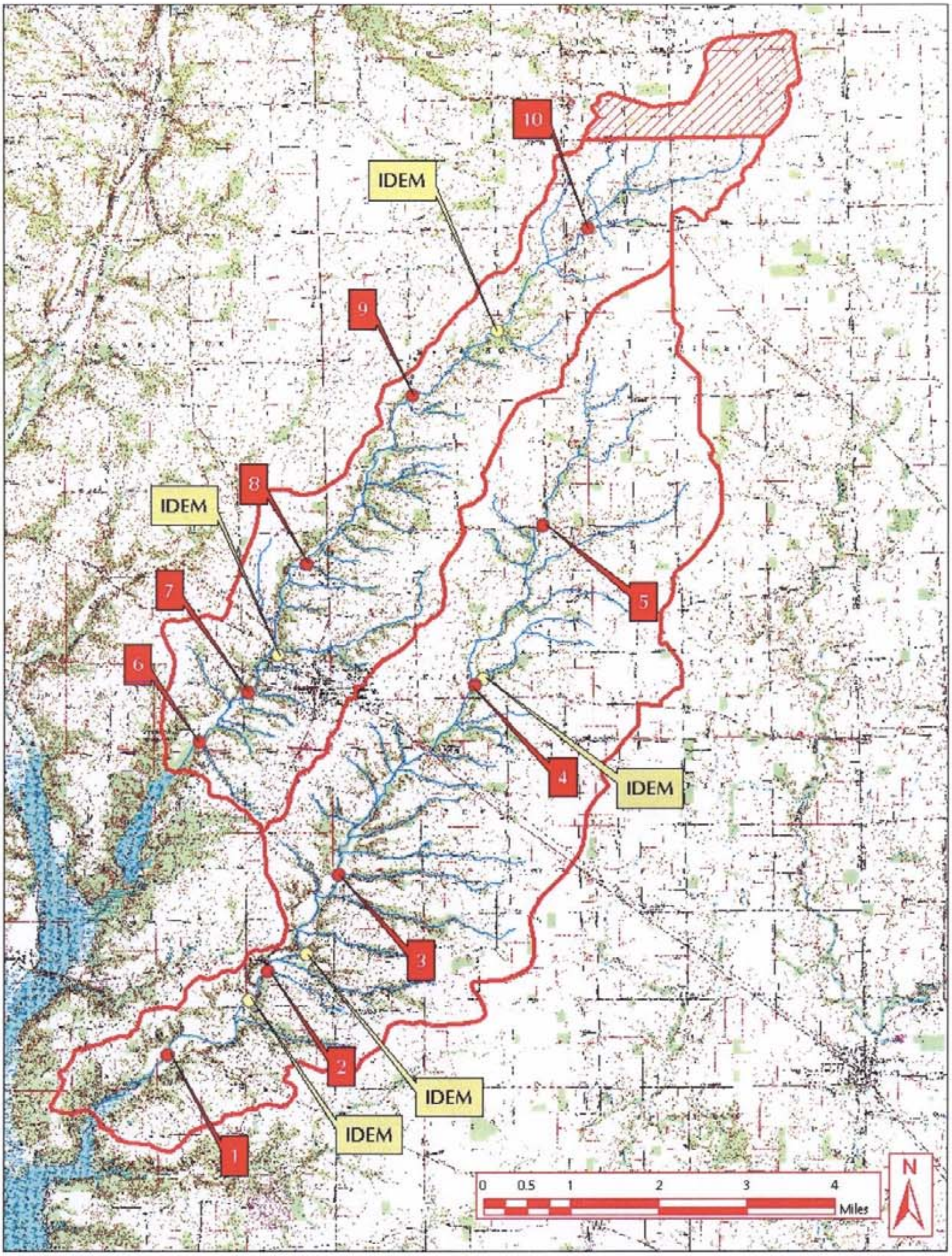
Sample point 9 is located on the Stout Road bridge. There is a considerable amount of livestock production upstream of this location.

Sample point 10 also has two locations. The flow monitoring point is located on the east side of the State Road 227 Bridge, at the headwaters of Silver Creek. The chemical and biological sampling point is located at the Mitchell Road bridge west of Witts Station and east of Foutz Road. This point was relocated to include more headwater tributaries.

ATTACHMENT

2.7. Sample locations map

Attachment 2.7. Sample locations map



3.0 BACKGROUND & FIELD WORK

3.1 Water Quality

The chemical and physical characteristics of the water in a stream provides significant information regarding water quality and the condition of the watershed. Analysis for specific indicators allows the investigator to determine if water quality problems exist, and if so, the probable causes of water quality problems.

3.1.1 Parameters

Information in this section is broken into two categories: physical parameters (temperature, pH, conductivity, dissolved oxygen, and flow velocity) and chemical parameters (turbidity, phosphate, nitrogen and fecal coliform). Standard and/or guideline levels for each parameter are cited below and tabulated in table 4.1. These levels are to serve only as a point of reference since the assumed sources of pollution are widespread, non-point sources and therefore, are not enforceable.

3.1.1.1 Physical Parameters

Temperature is a measure of the amount of heat in water. The state guidelines regarding water temperature are as follows:

1. There shall be no abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions.

2. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

3. The maximum temperature rise at any time or place above natural temperatures shall not exceed 5 degrees Fahrenheit in streams.

4. Water temperatures shall not exceed the following maximum limits during more than one percent of the hours in the 12 month period ending with any month; at no time shall the water temperature exceed the maximum limits below by more than 3 degrees Fahrenheit.

January	50°F	May	80°F	September	90°F
February	50°F	June	90°F	October	78°F
March	60°F	July	90°F	November	70°F
April	70°F	August	90°F	December	57°F

pH - A scale used to determine the alkaline or acidic nature of a substance. The scale ranges from 1-14 with 1 being the most acidic and 14 the most basic. Pure water is neutral with a pH of 7. The Indiana water quality standard for pH is between 6.0 and 9.0. Daily fluctuations above 9.0 that are correlated with photosynthetic activity are permitted.

A pH range of 6.5 to 8.2 is optimal for most organisms. Rapidly growing algae and vegetation remove carbon dioxide (CO^2) from the water during photosynthesis, which can result in a significant increase in pH. Most natural waters have pH values from 5.0 to 8.5. Acidic, freshly fallen rainwater may have a pH of 5.5 to 6.0. Alkaline soils and minerals (limestone) can raise pH to 8.0-8.5. Seawater usually has a pH close to 8.0.

Dissolved Oxygen (DO) - The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water is usually expressed in milligrams per liter, parts per million, or percent of saturation. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odors. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life. Levels between 5 and 10 milligrams per liter (mg O_2/L) are considered optimal and most fish cannot survive for prolonged periods at levels below 3 mg O_2/L. Levels below 1 mg O_2/L are often referred to as *hypoxic* and when O_2 is totally absent *anoxic* (often called anaerobic, which technically means *without air*). The Indiana water quality standard for dissolved oxygen is an average concentration greater than 5 mg O_2/L, and not less that 4 mg O_2/L. In streams designated for cold-water fish, the water quality standard is greater than 6 mg O_2/L. Levels above 10 mg O_2/L are considered to be supersaturated and are indicative of an unstable ecology. One model for a supersaturated DO condition suggests that the condition is the result of algal bloom and that subsequent die-off can consume DO and depress DO levels below that necessary to support aquatic life.

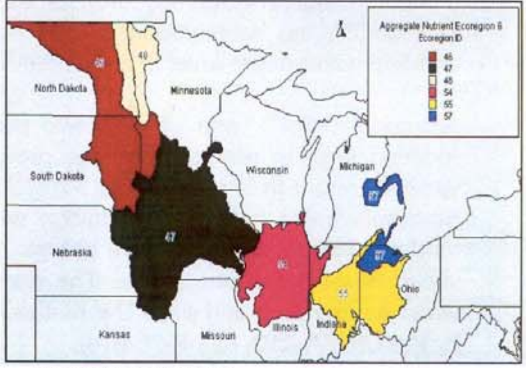
Conductivity - Measures water's ability to conduct an electric current and is directly related to the total dissolved salts (ions) in the water. Called EC for electrical conductivity, it is reported in micromhos per centimeter (μmhos/cm). EC is temperature sensitive and increases with increasing temperature. Most modern probes automatically correct for temperature and standardize all readings to 25°C and then refer to the data as *specific conductance*. There is no standard for conductivity in Indiana; however, the USEPA cites a range of 150 - 500 μmhos/cm as healthy for most fish and macroinvertebrate species, as part of the Voluntary Stream Monitoring program (EPA 841-B-97-003).

Flow Velocity – Measures the volume of water that is flowing past a particular point within a given period of time. Flow velocity is an essential parameter in that, for a given pollutant concentration in the stream flow, it is possible to determine the pollutant loading in the watershed. Flow velocity, recorded as cubic feet per second (cf/s), was measured once a month during 2001, including sampling events, in preparation of an annual flow profile.

3.1.1.2 Chemical Parameters

Turbidity is a measure of the water clarity. Sources of turbidity include soil erosion, urban runoff, construction activity, algal blooms and bottom disturbance, commonly from boats and bottom-feeding fish. There is no standard for turbidity in Indiana; however, the Hoosier Riverwatch program lists 1 to 10 nephelometric turbity units (NTU) as excellent. The United States Environmental Protection Agency (USEPA) has recommended 10.4 NTU as a standard of turbidity in ambient water in the level III ecoregion 55 (see Figure 3.1).

Figure 3.1. Ecoregion VI with level III ecoregions delineated



Source: EPA 822-B-00-017

Phosphate - Phosphorous is a nutrient that is common in water, occurring as phosphate (PO_4^+). Phosphate is evaluated as both ortho (dissolved) phosphate and total phosphate. Dissolved phosphate is defined as that which passes through a 0.45 μm-pore filter. The decomposition of organic matter in a stream is the major source of dissolved phosphate. Total phosphate is a measure of both dissolved and non-dissolved phosphate. Phosphates, having a net positive charge, bind readily to soil particles, tending to have a net negative charge. Therefore, phosphates that are applied to agricultural fields in the form of fertilizers can be transported into streams, bound to soil particles, via runoff. For Lake Michigan, the Indiana water quality standard for total phosphates is less than 0.04 mg/L (327 IAC 2). For the balance of the state no standard has been established, but the 0.04 mg/L level is a threshold value (guideline) for review purposes. The USEPA standard for ortho-phosphates is less than 0.05 mg/L for streams discharging into lakes (USEPA 1987).

Phosphates are regarded as the limiting nutrient in watershed management. Nitrogen is generally available in the atmosphere and is delivered to the watershed through a variety of mechanisms. Phosphates only form from solid substances, so are more readily managed.

Nitrogen is the most prevalent element in the world. Nitrogen is the key constituent of plant proteins, chlorophyll, and nucleic acids (DNA and RNA). Therefore, nitrogen is *the key* nutrient. However, approximately 99% of nitrogen is in an organic form. Organic nitrogen is not available for plant uptake. Plant available nitrogen is often deficient in agricultural soils. Nitrogen is found in water from multiple sources, including human and animal waste, decomposing organic matter and fertilizer. Nitrogen is measured as various forms in water, including total Kjeldahl nitrogen (TKN), ammonia (NH_4^+), nitrate (NO_3^-) and nitrite (NO_2^-). These measurements are described as follows:

TKN measures nitrogen in the form of organic proteins and/or their decomposition product ammonia, as measured by the Kjeldahl Method. It is important because organic loading (from organic nitrogen) represents oxygen demand. TKN is a parameter that is frequently used as an indicator of industrial pollution and sewage. The USEPA has recommended 0.04 mg/L as a standard for TKN concentration in ambient water in the level III ecoregion 55 (EPA 822-B-00-017).

Ammonia (NH_4^+), one of only two plant available forms of nitrogen, is the most reduced form of nitrogen and the product of organic decomposition. Ammonia is usually present in low (less than 1 mg/L) levels in unpolluted, well-oxygenated waters. Ammonia has a net positive charge, which binds readily to clay-based soils, which tend to produce a net negative charge. The mechanism by which ammonia enters a stream is similar to phosphate. The standard for ammonia in Indiana is dependent on water temperature and pH. The method for determining the standard was established by the USEPA (EPA 822-R-99-014).

Nitrate (NO_3^-), the other plant available form of nitrogen, and nitrite (NO_2^-) are oxidized forms of nitrogen resulting from the nitrification (bacterial oxidation) of ammonia. Nitrate and nitrite both have net negative charges and, therefore, do not bind readily with soil particles. For this reason, these forms of nitrogen are more likely to leach through the soil profile rather than be transported with soil runoff. Nitrate and nitrite have been found in high concentrations in groundwater where, if consumed via well water, can cause significant health concerns. Nitrate nitrogen is usually present in low concentrations in natural water, and is the most abundant inorganic form of nitrogen. Nitrates are reduced to nitrites by the digestive system. The water quality standard for nitrate is 10 mg/L nitrate-nitrogen (NO_3-N) which is equivalent to 44 mg/L NO_3 (327 IAC 2). The water quality standard for nitrite is 1.0 mg/L (327 IAC 2).

Fecal coliform consists of bacteria found in the feces of warm-blooded animals, including humans, livestock and waterfowl. The presence of fecal coliform is rare in unpolluted waters. Common sources of fecal coliform include combined sewer overflows (CSOs) in urban areas, leaking septic systems, feedlot runoff, and direct discharges of untreated sewage.

Indiana's standard for fecal coliform exists as a standard for a particular variety of fecal colliform, E. coli. Indiana Administrative Code (IAC), Title 327, Chapter 2 Section 1.5-8(e)(2) establishes bacteriological quality for recreational uses as follows: "E. coli bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period."

The USEPA standards for fecal coliform concentrations is as follows:

- •Drinking water: Less than 1.0 colony-forming units (cfu)/100 ml of total coliforms (approximately 0.1 fecal coliform)
- •Total body contact: Less than 200 cfu/100 ml of total coliforms
- •Partial body contact: Less than 1,000 cfu/100 ml of total coliforms
- •Treated sewage effluent: Less than 2,000 cfu/100 ml of total coliforms

In this report, the USEPA standard for partial body contact is referenced.

3.1.2 Sampling

Two sampling events occurred at each sample location, storm (high) flow and low flow. High flow sampling measures constituent concentrations during a significant precipitation period, when a large volume of water is draining the watershed via runoff and artificial drainage. Low flow sampling measures constituent concentrations during base flow (average) conditions. Projections for sampling events were based on historic climatic data for Union County.

Temperature, pH, conductivity, dissolved oxygen, and flow velocity measurements were completed in the field at the time of sample acquisition. Temperature, pH and conductivity were measured with a Hydac conductivity/temperature/pH meter. Dissolved oxygen was measured with a YSI Model 55 dissolved oxygen meter. A FP-201 from Global Water was used to measure velocity following the United States Geological Society Small Stream method. Permanent transects across the stream, running perpendicular to the flow, were established at each sample location and marked with surveyors tape attached to an adjacent tree.

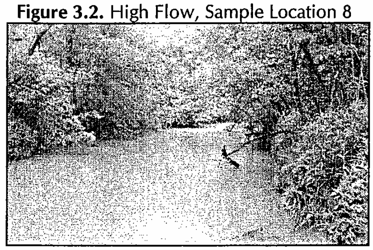
The cross-sectional area was measured at each site for each event. Stream width was measured and recorded first. Stream depth was then measured and recorded at two foot increments along each transect. The cross-sectional area was calculated by multiplying the stream width with the average stream depth. Vertical flow-averages were measured by the flow meter and recorded at the same two-foot increments. Flow was measured to the nearest 0.1 foot per second (f/s). Flow that was not detectable by the meter was recorded as <0.1 f/s. Flow velocity, reported as cubic feet per second (cfs), was calculated by averaging the vertical flow-averages and multiplying it by the cross-sectional area.

Nitrate, nitrite, total Kjeldahl nitrogen, ammonia, total phosphate, ortho phosphate, turbidity and fecal coliform analysis was performed in the laboratory by Hoosier Microbiological Laboratories (Hoosier) in Muncie, Indiana. Water samples were collected and cooled to 4°C prior to delivery to the laboratory. Due to the six-hour hold time for fecal coliform samples, samples were immediately delivered to the laboratory by Sagamore personnel. Samples were transported under standard chain-of-custody protocols. Water samples were collected using a 12 foot long Bel-Art® handled dipper and a two gallon bucket. Samples were placed into sterilized, Nalgene® containers with Teflon® lined screw-top lids provided by Hoosier. Container types and associated preservatives were selected respective to analysis.

3.1.2.1 High Flow

High flow sampling occurred on May 18, 2001, toward the end of a three-day rain event that dropped over six inches of precipitation. Weather conditions were overcast with intermittent rain showers. The air temperature was 75° F.

Figure 3.2. High Flow, Sample Location 8



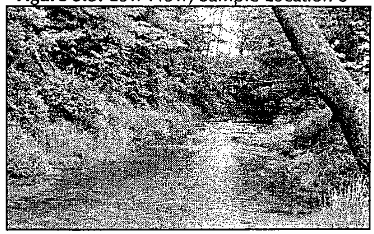
Photographed May 18, 2001

3.1.2.2 Low Flow

Low flow sampling occurred on September 17, 2001. To that point, it had been three weeks since a precipitation event. Weather conditions were hazy with a temperature of 80° F.

Results of the sampling events are discussed in the Section 4.

Figure 3.3. Low Flow, Sample Location 8



Photographed September 17, 2001

3.2 Macroinvertebrates

Macroinvertebrates or benthic macroinvertebrates are animals that do not have backbones and can be seen with the naked eye. Macroinvertebrates live mainly on the stream bottom or among debris on the bottom of a stream. The bottom dwellers are called benthic macroinvertebrates (benthic=bottom, macro=large, invertebrate=animal without a backbone). Most bottom dwellers are insects, but they can also be aquatic worms, crustaceans, snails, clams, or arachnids. The vast majority of stream-dwelling macroinvertebrates live in riffle areas. Riffles are areas of fast, shallow water with a bedrock bottom with rocky particles ranging in size from cobbles to gravel.

Figure 3.4. Stonelfy larva

Source: University of Virginia, 2001

Macroinvertebrates provide a quick view of the water quality of a watershed. Because they live in the water for all or most of their lives and have complex life cycles of one year or more, macroinvertebrates are able to reflect the effects of short-term environmental variations. Sampling macroinvertebrates is advantageous for the following reasons: 1) they differ in their tolerance to amounts and types of pollution; 2) they are easy to identify; 3) they are easy and inexpensive to collect; 4) they are good indicators of localized conditions because of their limited migration patterns; 5) they are abundant in most streams; and, 6) they are a primary source of food for fish.

Prior to sampling, a request was submitted to the IDNR for the taking of species from state property, being that sample points 1 and 6 are located within state recreational areas. Copies of the authorization from the IDNR are included in Appendix H.

Macroinvertebrates for this project were sampled on November 6, 2001. August was the proposed month for this sampling but it was unseasonably wet and water levels were high. The months of September and early November provided a look at the watershed's quality during the harshest conditions of the year with water levels being lower, higher water temperatures, and lower amounts of dissolved oxygen. Macroinvertebrate results will be compared to the Indiana Department of Environmental Management (IDEM) data collected previously in August of 1994.

Sampling methods followed the multihabitat approach protocols described in the *Rapid Bioassessment Protocols for Use in Streams and Rivers*, produced by the United States Environmental Protection Agency (USEPA). Two teams of two and one team of three persons sampled for macroinvertebrates. Team members included two individuals from the Union County Soil and Water Conservation district and five individuals from Sagamore Environmental Services, Inc. Weather conditions on the sampling day was 70°F and sunny.

Figure 3.5. Sampling with kick net (kicks)

Figure 3.5. Sampling with "D" net (jabs)

Photographed November 6, 2001

Four main habitat types within a 100 meter area upstream from the ten sample points were sampled and collected. Habitat types that were focused on included cobbled areas, snags, vegetated banks, sand, and submerged macrophytes. Different types of habitat were sampled in approximate proportion to their representation of surface area of the total macroinvertebrate habitat in the reach. Sampling began at the downstream end of the reach and proceeded upstream. A total of 20 jabs or kicks were taken over the length of the reach. The 20 jabs or kicks collected from multiple habitats were composited to obtain a single homogeneous sample.

Collected macroinvertebrates were kept in glass vials containing 90% isopropyl alcohol and stored on ice in the field until they could be refrigerated. The samples were sent to Dr. Horst F. Siewert, Professor at Ball State University for identification.

3.3 Habitat Assessments

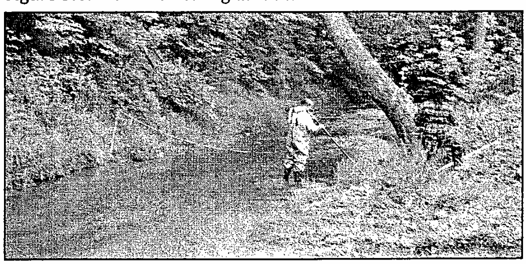
The presence of organisms in a stream is strongly related to the physical and chemical characteristics of the stream. The habitat provides shelter for organisms, attachment sites to grow on, turbulent areas for mixing with oxygen, and areas to hunt or graze on algae. Shifts in the make-up of the community are responses to nutrient availability and habitat changes. Organisms intolerant of pollution (natural or man-made) tend to be found in habitat having a lot of cover, a variety of flows, different substrates that are clear of silt and sand, and low levels of toxic material in the water. Generally, pollution tolerant organisms tend to be associated with slow moving water, live much of their life in silt and sediment and tend to exhibit adaptability to a wide range of environmental conditions.

The Qualitative Habitat Evaluation Index (QHEI), developed by the Ohio EPA, gives an estimate of the suitability of a stream segment to meet warm water habitat for aquatic organisms. The QHEI quantifies specific aspects of stream habitat in six different categories. The sum of the scores yields the total score for each sample location.

A QHEI Assessment was performed on each site throughout both watersheds on September 21, 2001. A two-person team was assigned to each watershed. Each team assessed the sample locations in the respective watersheds. In an attempt to minimize subjectivity, the scores from each location were averaged.

3.4 Flow Monitoring

Figure 3.6. Flow monitoring at location 8



Photographed May 14, 2001

Flow monitoring has been conducted on a monthly basis at each sample point, beginning in January, 2001, through December, 2001 (Figure 9.1). Data obtained from the flow monitoring can be used for establishing an erosion mitigation plan. In general, erosion increases with flow velocity. Identifying reaches with high stream flow potentially identifies sources for downstream sedimentation.

4.0 RESULTS

Overall, Silver Creek and Hanna's Creek are typical for the region. The results of the analyses were shared with Mr. Chuck Bell, IDEM, Assessment Branch. According to Mr. Bell, constituent concentrations are within the range of what is expected in streams in east central Indiana. Chemical and physical analysis of Silver Creek and Hanna's Creek were performed by IDEM, Surveys Section in 1997. As part of the Watershed Monitoring Program, the Surveys Section is responsible for sampling and assessing the quality of 35,673 miles of waterways and determining the effect of approximately 1,800 permitted point sources on receiving streams. Results of these events are presented as historic data. Only those constituents that relate to the purpose of this study are included. For the purpose of discussion and interpretation, each stream will be discussed individually.

4.1 Water Quality

For purposes of reference, results were compared to state averages, when available, and standards/guidelines for each parameter. Standards and guidelines for surface water quality were taken from Indiana Administrative Code 327 (327 IAC 2), IDEM, the USEPA, and the Hoosier Riverwatch program. For purposes of this study, the USEPA fecal coliform standard for partial body contact will be referenced. Standards and guidelines are cited for reference purposes only and are not enforceable. State averages and parameter standards/guidelines and their respective agencies are listed in the following table:

Table 4.1. Parameter Averages and Standards/Guidelines

Parameter	*State Average*	*Standard (S)/Guideline (G)*	*Agency*
Temperature	n/a	> 5° F downstream(S)	327 IAC 2
Dissolved Oxygen	n/a	> 5 ppm(G)	Hoosier Riverwatch
Conductivity	n/a	150 - 500 (μhos/cm)(S)	EPA 812-B-97-003
PH	6 – 9	6.5 – 8.2(G)	Hoosier Riverwatch
Nitrate	n/a	44 mg/L(S)	327 IAC 2
Nitrite	0.0279 mg/L	1.0 mg/L(S)	327 IAC 2
TKN	1.1328 mg/L	0.4 mg/L(S)	EPA 822-B-00-017
Total Phosphorous	0.1709 mg/L	0.04 mg/L(G)	327 IAC 2
Ortho Phosphorous	0.0661 mg/L	0.05 mg/L(S)	USEPA 1987
Fecal Coliform	n/a	1,000 cfu/100 ml(S)	EPA 823-R-98-003
Turbidity	25.4323 NTU	10.4 NTU(S)	EPA 822-B-00-017

n/a – not available

The standard for ammonia is set forth by the USEPA in *1999 Update of Ambient Water Quality Criteria for Ammonia* (EPA 822-R-99-014), which serves to update 327 IAC 2. According to this document, ammonia standards of ambient water are a function of water temperature and pH. The state average ammonia concentration is 0.2686 mg/L. The ammonia standards for each site per event are listed in the following table:

Further discussion on the standards and guidelines presented in subsequent sections of this report can be found in Section 3.

Table 4.2. Ammonia Standards (mg/L)

Hanna's Creek			Silver Creek		
Sample Point	*High*	*Low*	*Sample Point*	*High*	*Low*
1	0.963	0.380	6	1.910	0.882
2	1.880	0.451	7	2.090	0.435
3	1.870	0.638	8	1.940	0.752
4	2.120	0.500	9	0.964	1.970
5	2.140	0.343	10	2.100	0.456

4.1.1 Hanna's Creek (Historic)

Results of 1997 IDEM sampling in Hanna's Creek are in the following tables. Concentrations that exceed standards/guidelines presented in Table 4.1 are indicated in bold.

Table 4.3. Results of IDEM's Physical Measurements for Hanna's Creek

Sample Point	*Temp. (°F)*	*pH*	*Conductivity (μmhos/cm)*	*DO (ppm)*
GMW070-0010	68.8	8.1	670	6.42
GMW070-0011	77.0	**8.5**	535	9.75

Table 4.4. Results of IDEM's Chemical Measurements for Hanna's Creek

Sample Point	*Nitrate + Nitrite (mg/L)**	*TKN (mg/L)*	*Total P (mg/L)*	*Turbidity (NTU)*
GMW070-0010	3.2	**0.47**	< 0.05	**25.1**
GMW070-0011	2.1	0.24	< 0.05	not sampled

* *Indiana state surface water quality standard for nitrate + nitrite is 10 mg/L (327 IAC 2).*

4.1.2 Hanna's Creek (Current)

Results of water analysis for Hanna's Creek are presented in the following tables. Parameters listed in bold exceed reference conditions. Refer to Tables 4.1 and 4.2 for reference conditions. Attachment 4.1 includes graphical representations of selected data.

Table 4.5. Results of Field Measurements for Hanna's Creek

Sample Point		*Temp. (°F)*	*pH*	*Conductivity (μmhos/cm)*	*DO (ppm)*
1	high	64.6	8.13	**589**	8.48
	low	72.1	**8.50**	**713**	9.29
2	high	64.3	7.77	**605**	8.67
	low	69.5	**8.46**	**797**	9.80
3	high	66.6	7.77	427	8.45
	low	68.0	**8.32**	**956**	8.90
4	high	64.0	7.58	487	8.01
	low	72.3	**8.36**	**880**	9.46
5	high	61.1	7.65	**667**	7.95
	low	73.8	**8.52**	**630**	**10.56**

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Table 4.6. Laboratory Results for Hanna's Creek

Sample Point		*Nitrate (mg/L)*	*Nitrite (mg/L)*	*TKN (mg/L)*	*Ammonia (mg/L)*	*Total P (mg/L)*	*Ortho P (mg/L)*	*Fecal (CFU/100mL)*	*Turbidity (NTU)*
1	high	27	0.1	0.3	0.2	**0.4**	**0.3**	**7,000**	**70**
	low	6.0	<0.01	0.4	0.2	**0.6**	<0.1	200	0.9
2	high	26	0.2	**1.9**	0.3	**0.6**	**0.6**	**10,000**	**47**
	low	8.6	0.01	**0.8**	0.4	**0.2**	<0.1	180	0.6
3	high	28	0.2	**0.9**	0.3	**0.6**	**0.5**	**4,000**	**60**
	low	9.4	<0.01	**0.9**	0.2	**0.2**	<0.1	380	0.5
4	high	33	0.1	0.3	0.3	**1.1**	**0.9**	**5,000**	**61**
	low	11	0.01	0.4	0.1	**0.4**	<0.1	360	0.9
5	high	37	0.1	0.3	0.3	**0.4**	**0.4**	**6,000**	**18**
	low	15	0.01	0.1	0.1	**0.5**	**0.4**	230	0.7

Temperature and dissolved oxygen levels in Hanna's Creek are within acceptable ranges at most sample points during high and low flow sampling events as well as historic sampling. During low flow conditions supersaturated DO levels were detected at sample point 5. This is indicative of an unstable condition. Conductivity was slightly elevated. pH was slightly caustic during low flow.

Nitrate, nitrite, and ammonia levels were below the respective reference standards during both sampling events. Nitrate levels during high flow sampling were elevated, and are significantly higher than low flow sampling. Nitrite levels were low and well below the water quality standard; yet, were significantly higher during high flow. Ammonia levels were also relatively low.

TKN, phosphorous (total and ortho), fecal coliform, and turbidity concentrations were reported above reference standards. Total Phosphorus levels were above the water quality guideline in all samples acquired. Ortho phosphate analysis indicates that most, but not all of the phosphate in Hanna's Creek during high flow periods is dissolved, while the low flow samples were primarily non-dissolved phosphate. During high flow sampling, the water in Hanna's Creek was brown and cloudy, conversely, during low flow sampling, the water was clear and colorless. As such, the turbidity readings were relatively high during the high flow event, and very low during the low flow event. Fecal coliform counts were significantly above the standard at all sampling locations during high flow sampling. TKN concentrations were above the referenced standard at two locations (2 and 3) for both sampling events.

Nitrate, nitrite, ortho phosphorous, turbidity and fecal coliform levels were significantly higher in samples acquired during the high flow-sampling event compared to the low flow event. The high turbidity levels, combined with visual observation, indicate that soil particles contained in storm water runoff are the major contributor to turbidity. The elevated nitrate and ortho phosphorous levels are most likely due to fertilizer runoff. The most likely sources of the high fecal coliform counts, and elevated TKN at location 2 and 3, are land application of manure, feedlots and pasture areas.

4.1.3 Silver Creek (Historic)

Results of 1997 IDEM and 1976 USEPA sampling in Silver Creek are in the following tables. The USEPA data is based upon an average of a twelve-month study (no physical parameters were measured in Silver Creek). Concentrations that exceed reference conditions are indicated in bold. Refer to Tables 4.1 and 4.2 for reference conditions. Attachment 4.1 includes graphical representations of selected data.

Table 4.7. Results of IDEM's Physical Measurements for Silver Creek

Sample Point	*Temp. (°F)*	*pH*	*Conductivity (μmhos/cm)*	*DO (ppm)*
GMW070-0008	59.9	8.2	651	8.86

Table 4.8. Results of IDEM's Chemical Measurements for Silver Creek

Sample Point	*Nitrate + Nitrite (mg/L)**	*TKN (mg/L)*	*Total P (mg/L)*	*Turbidity (NTU)*
GMW070-0008	**13**	0.39	0.05	**23.8**
1839AA	**16.9**	**0.85**	**3.25**	not available

** Indiana state surface water quality standard for nitrate + nitrite is 10 mg/L (327 IAC 2).*

4.1.4 Silver Creek (Current)

Results of water analysis for Silver Creek are presented in the following tables. Parameters listed in bold exceed water quality standards/guidelines. Refer to Tables 4.1 and 4.2 for reference conditions.

Table 4.9. Results of Field Measurements for Silver Creek

Sample Point		*Temp. (°F)*	*pH*	*Conductivity (μmhos/cm)*	*DO (ppm)*
6	high	65.7	7.76	**550**	8.45
	low	**64.1**	8.17	**870**	6.80
7	high	65.7	7.70	**778**	8.64
	low	**68.2**	**8.50**	**789**	7.80
8	high	64.0	7.75	**636**	8.45
	low	**68.2**	**8.24**	**670**	9.69
9	high	64.1	8.13	**654**	8.63
	low	**69.6**	7.62	**705**	7.88
10	high	62.9	7.70	**667**	7.50
	low	**71.5**	**8.42**	**1063**	**12.75**

Table 5.10. Laboratory Results for Silver Creek

Sample Point		*Nitrate (mg/L)*	*Nitrite (mg/L)*	*TKN (mg/L)*	*Ammonia (mg/L)*	*Total P (mg/L)*	*Ortho P (mg/L)*	*Fecal (CFU/100mL)*	*Turbidity (NTU)*
6	high	19	0.2	**2.8**	0.4	**1.1**	**1.0**	**50,000**	**101**
	low	5.4	0.02	0.2	0.2	**0.6**	**0.2**	**1,810**	**29.8**
7	high	21	0.1	**2.5**	0.3	**0.9**	**0.8**	**15,000**	**118**
	low	6.8	0.01	0.2	0.2	**0.5**	**0.4**	500	3.2
8	high	23	0.1	**1.5**	0.2	**0.5**	**0.4**	**10,000**	**81**
	low	3.1	0.01	0.3	0.2	**0.4**	**0.1**	290	2.6
9	high	29	0.1	0.3	0.3	**0.4**	**0.4**	**6,000**	**50**
	low	4.7	0.02	0.4	0.3	**0.3**	**0.2**	990	4.3
10	high	32	0.07	0.2	0.2	**0.1**	**0.1**	**1,900**	**19**
	low	15	0.04	0.2	0.2	**0.3**	**0.1**	**8,000**	1.0

Dissolved oxygen levels in Silver Creek are within acceptable ranges at most sample points during high and low flow sampling events. During low flow at sample point 10 supersaturated DO was detected, indicative of an unstable condition. Conductivity was elevated, particularly at sample location 10 during low flow. pH was slightly caustic at points 7, 8, and 10 during low flow. Temperature change exceeded 5° F during low flow; however, the temperature change was not significant and could be attributed to diurnal temperature fluctuations.

As with Hanna's Creek, nitrate, nitrite, and ammonia levels were below the respective reference standards during both sampling events. Nitrate levels during high flow sampling were elevated, and are significantly higher than low flow sampling. Nitrite levels were low and well below the water quality standard; yet, were significantly higher during high flow. Ammonia levels were also relatively low.

TKN, phosphorous (total and ortho), fecal coliform, and turbidity concentrations were reported above reference standards or guidelines. Unlike Hanna's Creek, the ortho phosphate analysis indicated that most, but not all, of the phosphate in Silver Creek during both high and low flow periods is dissolved. As with Hanna's Creek, water in Silver Creek during the high flow sampling was brown and cloudy, but clear and colorless during low flow sampling. As such, the turbidity readings were relatively high during the high flow event, and very low during the low flow event.

Fecal coliform counts were high during low flow sampling, and very high during high flow sampling. Fecal coliform counts in both creeks exceeded the USEPA water quality standard at all sampling points during the high flow event. Two locations in Silver Creek (6 and 10) had fecal coliform counts above the standard during the low flow event. All locations in Hanna's Creek were below the standard during the low flow event. TKN concentrations were above reference standards at three locations (6, 7, and 8) during high flow sampling.

As with Hanna's Creek, the same conclusions can be drawn regarding nitrate, nitrite, ortho phosphorous, turbidity and fecal coliform results. Nitrate, nitrite, ortho phosphorous, turbidity and fecal coliform levels were significantly higher in samples acquired during the high flow-sampling event compared to the low flow event. The high turbidity levels, combined with visual observation, indicate that soil particles contained in storm water runoff are the major contributor to turbidity. The elevated nitrate, nitrite and phosphorous levels are likely due to fertilizer runoff. The most likely sources of the high fecal coliform and TKN are land application of manure, feedlots, pasture areas, and leaking septic systems in residential areas. The fecal coliform counts in Silver Creek increased from upstream to downstream during the high flow event, indicating that cumulative coliform loading occurs in Silver Creek during storm events. Conversely, TKN concentrations were highest upstream and decreased downstream which indicates dilution of an upstream source. Additionally, a high coliform count was obtained at the far upstream sampling point in Silver Creek during the low sampling event, indicating that a localized source is present in

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this area. Potential sources include feedlots or pasture areas immediately adjacent to or with livestock access to Silver Creek.

4.2 Flow Monitoring

Flow monitoring occurred on a monthly basis throughout 2001. Discharge, measured in cubic feet per second (cfs), and flow, measured in feet per second (f/s), was recorded. Results of the discharge monitoring are included in Table 4.11. Any series with less than three measurements were not averaged due to statistical insignificance.

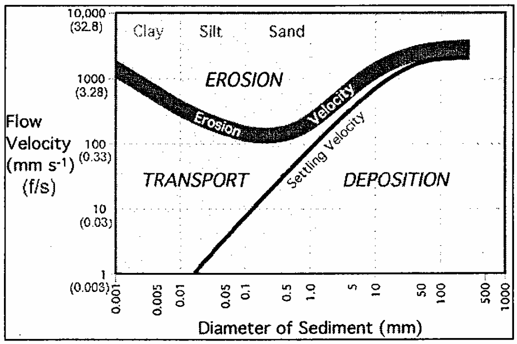
Table 4.11. Flow Monitoring Data: Discharge Averages (cfs)

Location	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Avg.*
Hanna's	60.0	13.3	25.0	X	9.4	X	3.9	X	2.5	X	120.0	69.8	**39.6**
Silver	26.4	7.8	12.4	9.2	5.7	X	2.0	0.4	1.0	X	17.7	38.8	**15.8**

X – Not enough values to average due to either equipment failure or unsafe conditions

Both watersheds drain quickly. During high flow conditions, flow velocity is significantly elevated; yet, returns to normal flow conditions within a short period of time. The volume of water discharging from Hanna's Creek is more than double the volume discharging from Silver Creek. Considering that the Hanna's Creek watershed is nearly twice the size of the Silver Creek watershed, this seems appropriate.

Figure 4.1. Hjulstrom's Diagram



Source: M.J. Pidwirng, PhD, Okanagan College University, British Columbia, Canada

Table 4.12. Flow Monitoring Data: Flow (f/s)

Location		*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Avg.*
Hanna's Creek	1	*	*	*	*	*	*	0.34	Ef	0.17	unsafe	3.28	2.08	1.47
	2	3.60	1.26	3.17	Ef	1.84	unsafe	0.58	Ef	0.55	unsafe	7.49	5.30	2.97
	3	2.88	0.77	1.61	Ef	0.59	unsafe	0.28	Ef	0.25	unsafe	4.33	2.26	1.62
	4	1.67	0.87	1.88	Ef	0.80	unsafe	0.21	0.27	0.14	unsafe	2.53	1.74	1.12
	5	1.53	0.40	0.79	0.88	0.87	unsafe	0.21	Ef	0.19	unsafe	2.64	1.88	1.04
	Avg.	2.42	0.83	1.86		1.03		0.32		0.26		4.05	2.65	1.66
Silver Creek	6	*	*	*	*	*	*	0.32	Ef	0.33	unsafe	0.30	0.97	0.48
	7	1.97	0.46	0.78	Ef	0.65	unsafe	0.32	Ef	0.25	unsafe	3.31	1.21	1.12
	8	2.33	0.94	2.28	1.68	0.90	unsafe	0.20	0.23	0.10	unsafe	2.62	0.66	1.19
	9	0.77	0.26	0.24	0.40	0.10	unsafe	0.10	0.10	0.10	unsafe	0.10	1.57	0.37
	10	1.53	0.10	0.10	0.20	0.10	unsafe	0.10	0.10	0.10	unsafe	0.10	0.10	0.25
	Avg.	1.65	0.44	0.85	0.76	0.44		0.27	0.14	0.18		1.29	1.43	0.72

* - Awaiting permission from IDNR for property access, Ef – equipment failure, unsafe – unsafe conditions

An annual flow velocity profile was compiled for the watersheds (Table 4.12). Hjulstrom's Diagram (Figure 4.1) shows the relationship between flow velocity and erosion/transport/deposition dynamics. According to this data set, the flow in each creek is capable of transporting eroded sediment a majority of the year. At high flow conditions, the flow is adequate to cause scour within the creeks.

4.3 Benthic Macroinvertebrates

Macroinvertebrate sampling revealed a high concentration of species intolerant to pollution. Field Sheets from the macroinvertebrate sampling are included in Appendix 4.1. A macroinvertebrate identification report is included in Appendix 4.2.

Metrics used to evaluate macroinvetebrates for this project were the Hilsenhoff Biotic Index (HBI); the number of individuals per sample; the percent dominant taxon; the Ephemeroptera/Plecoptera/Trichoptera (EPT) count; the percent EPT; the chironomid count; the percent chironomids; and the EPT to chironomid ratio. Metrics used were obtained from four sources: *The Great Lakes Entomologist* written by William L. Hilsenhoff, Marion County Health Department's Metrics used for macroinvertebrate projects; IDEM tolerance values taken from Hilsenhoff, 1988; Regional Tolerance values from the Rapid Bioassessment Protocols, Second Edition.

4.3.1 Hilsenhoff Biotic Index (HBI)

For this analysis, each taxonomic group is assigned a tolerance value from 0 to 10. Ten represents taxa that are pollution tolerant and zero represents taxa that are pollution sensitive. HBI values increase as water quality decreases. The HBI is calculated by multiplying the number of organisms in each taxon by its pollution tolerance value, then adding these individuals together and dividing by the total number of individuals in the sample.

HBI = the sum of (Xi * t)/n

Xi = # of individuals in each taxon
t = tolerance values for each taxon
n = # of individuals in the sample

Table 4.13. HBI Explanations

Description/Designation *Family Level Biotic Index*	*Explanation*
0.00-3.75	Excellent
3.76-4.25	Very good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly poor
6.51-7.25	Poor
7.26-10.00	Very poor

•Number of Individuals

This analysis is the total count of individuals collected in a sample. It is used to help calculate percentages of EPT and chironomids per sample, the percent dominant taxa, and the HBI indexes.

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•Percent Dominant Taxon

This analysis is a measure of the percent composition of the most abundant family from the sample. A high percent dominance of one taxa is not favorable. Results should reflect a high diversity of taxon thus representing a high level of water quality and habitat types.

•EPT Count

This analysis is a count of the number of individuals in three generally pollution-sensitive orders- Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are referred to as EPT. A high variety and number of these orders is favorable. More pollution-sensitive orders that are present in a sample means that the water quality is less polluted.

•Percent EPT

This analysis is the EPT count divided by the total number of individuals in the sample. A high percentage is favorable.

•Chironomid Count

This analysis is the total of individuals in a sample that are chironomids (midge larvae). A low number is favorable.

•Percent Chironomids

This analysis compares the number of chironomids to the total number of individuals in a sample. A low percentage is favorable.

•EPT to Chironomid Ratio

This analysis is the EPT count divided by the chironomid count. A low chironomid abundance is favorable.

Table 4.14. Metric Summary for Macroinvertebrates in Hanna's Creek

Station	*HBI*	*# of Individuals*	*% Dominant Taxon*	*EPT Count*	*% EPT*	*Chironomid Count*	*% Chironomids*	*EPT to Chironomid Ratio*	*Explanation*
1	3.93	97	37.1	66	68.0	3	3.1	22.0	very good
2	3.90	101	83.2	86	85.2	1	1.0	86.0	very good
3	4.06	214	66.4	171	79.9	7	3.3	24.4	very good
4	4.29	35	28.6	16	45.7	2	5.7	8.0	good
5	5.75	95	41.1	14	14.7	11	11.6	1.3	fair

Table 4.15. Metric Summary for Macroinvertebrates in Silver Creek

Station	*HBI*	*# of Individuals*	*% Dominant Taxon*	*EPT Count*	*% EPT*	*Chironomid Count*	*% Chironomids*	*EPT to Chironomid Ratio*	*Explanation*
6	4.01	68	26.5	21	30.9	6	8.8	3.5	very good
7	4.50	14	35.7	6	42.9	2	14.3	3.0	good
8	3.81	31	3.2	18	58.1	3	3.2	6.0	very good
9	3.89	183	40.0	76	41.5	18	9.8	4.2	very good
10	5.04	193	32.6	33	17.1	63	32.6	0.5	fair

A comparison of macroinvertebrates collected by IDEM on August 25, 1994 and Sagamore on September 6, 2001 was evaluated. IDEM used one sample location within each of the respective watersheds. In comparing the information, points with similar characteristics and locations were chosen from each of the watersheds. This evaluation revealed that the water quality, as indicated by macroinvertebrates, in Hanna's creek has improved. Based on the available information, conditions in Silver Creek have remained relatively constant since 1994. Table 4.16 illustrates these comparisons.

Table 4.16. Metric Summary for Comparison of Historical Data versus Current Data

Station	*HBI*	*# of Individuals*	*% Dominant Taxon*	*EPT Count*	*% EPT*	*Chironomid Count*	*% Chironomids*	*EPT to Chironomid Ratio*	*Explanation*
Hanna	4.71	314	33.8	110	35	106	33.8	1.09	good
2	3.90	101	83.2	86	85.2	1	1.0	86.0	very good
Silver	3.82	127	31.5	81	63.8	12	9.4	6.75	very good
8	3.81	31	3.2	18	58.1	3	3.2	6.0	very good

4.4 Habitat Evaluation

The QHEI Assessment revealed that most sites posses adequate habitat for warm water species. The QHEI score is calculated by adding the results from each metric in the evaluation. The scores were interpreted as per Ohio EPA guidelines as follows:

- QHEI > 60: suitable for warm water habitat without use impairment
- QHEI between 45 and 60: may meet warm water habitat in certain circumstances
- QHEI < 45: impaired and would require modification to support warm water habitat

The results of the QHEI Assessments are included in Table 4.17. Results below 60% of the possible score are indicated in bold.

Table 4.17. QHEI Results (highest possible score listed for each metric)

Location		*Substrate (20)*	*Cover (20)*	*Channel (20)*	*Riparian (10)*	*Pool/Riffle (20)*	*Gradient (10)*	*QHEI (100)*
Hanna's	1	16	15	16	9	15	8	81
	2	16	15	16	9	**6**	8	70
	3	19	17	**10**	6	**7**	8	67
	4	17	16	16	9	**11**	8	72
	5	17	16	12	8	**11**	8	77
Silver Creek	6	**10**	**11**	**11**	10	**4**	8	**54**
	7	17	**11**	15	8	**11**	8	70
	8	16	16	16	7	14	10	79
	9	18	**10**	15	7	**11**	10	71
	10	19	**11**	14	6	**9**	10	69

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Overall, habitat quality was high throughout both watersheds. Deficient instream cover was slightly problematic in Silver Creek. Channel Morphology was low at locations 3 and 6. This was primarily due to low sinuosity and low development. Pool/Glide and Riffle/Run Quality is the only category deficient throughout most of both watersheds. This deficiency was most equated to depth, morphology, and substrate. Sample location 6 was the only site that was below 60. The evaluation revealed a high concentration of silt within the substrate, low sinuosity, poor development, and no riffles.

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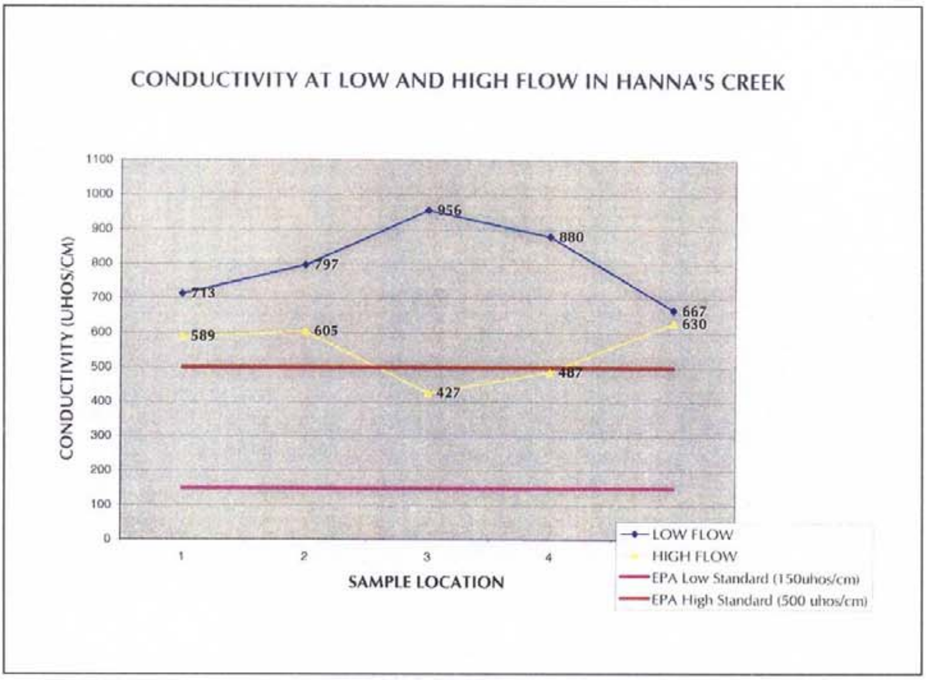
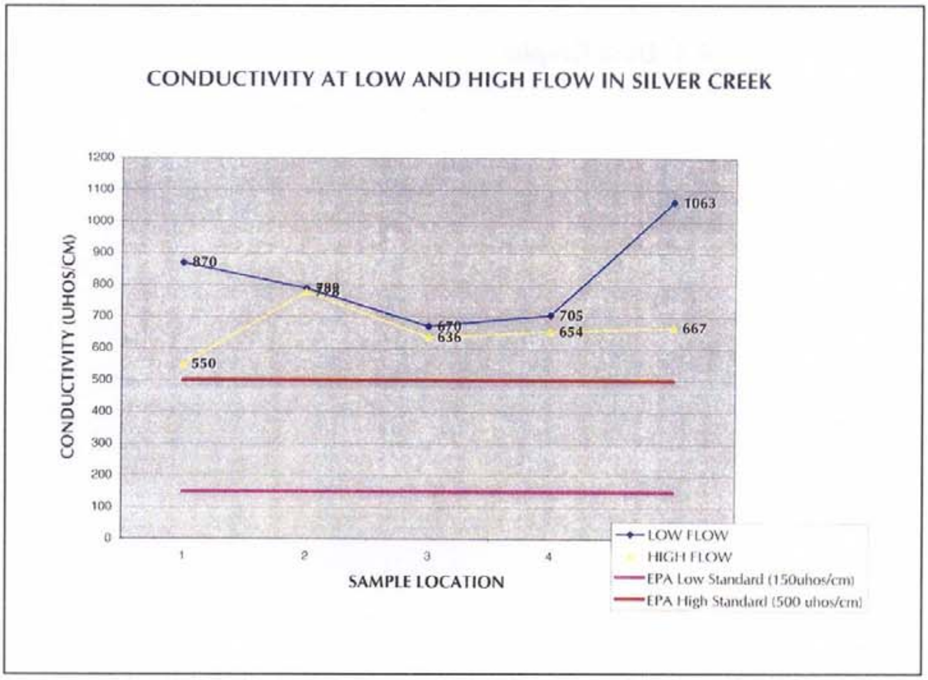
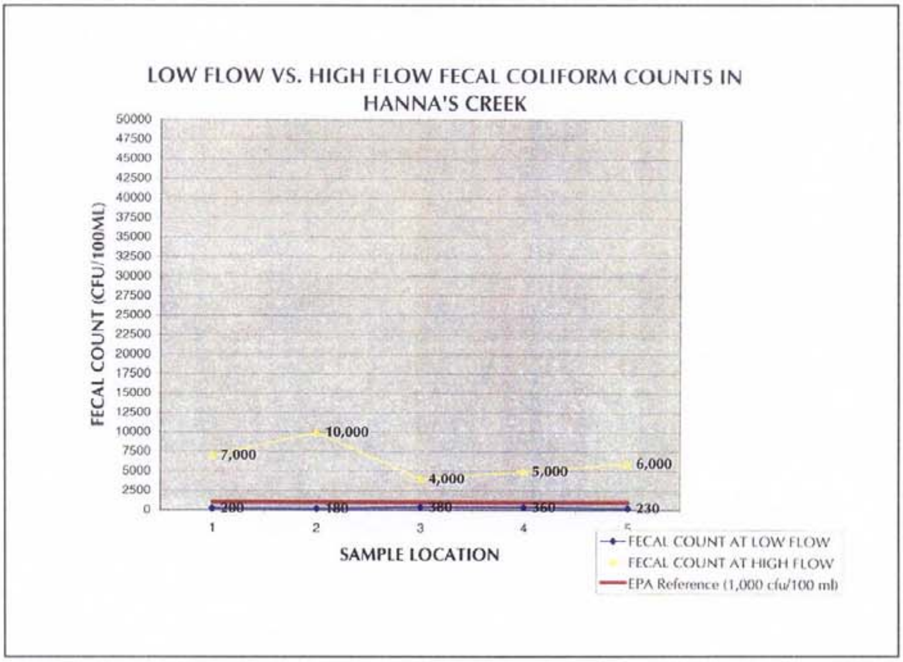
ATTACHMENT

4.1. Data Graphs

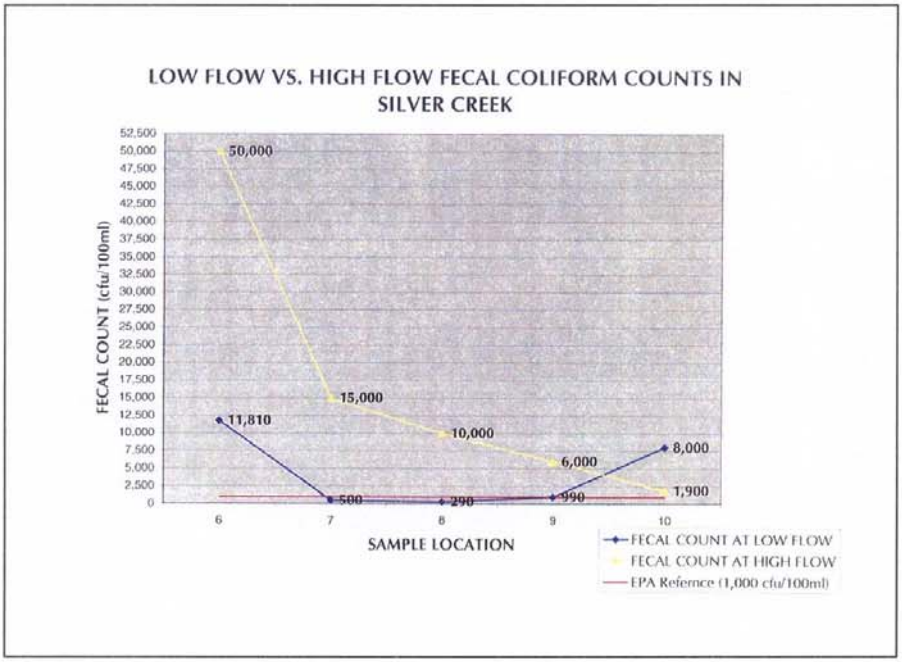
Attachment 4.1. Data graphs



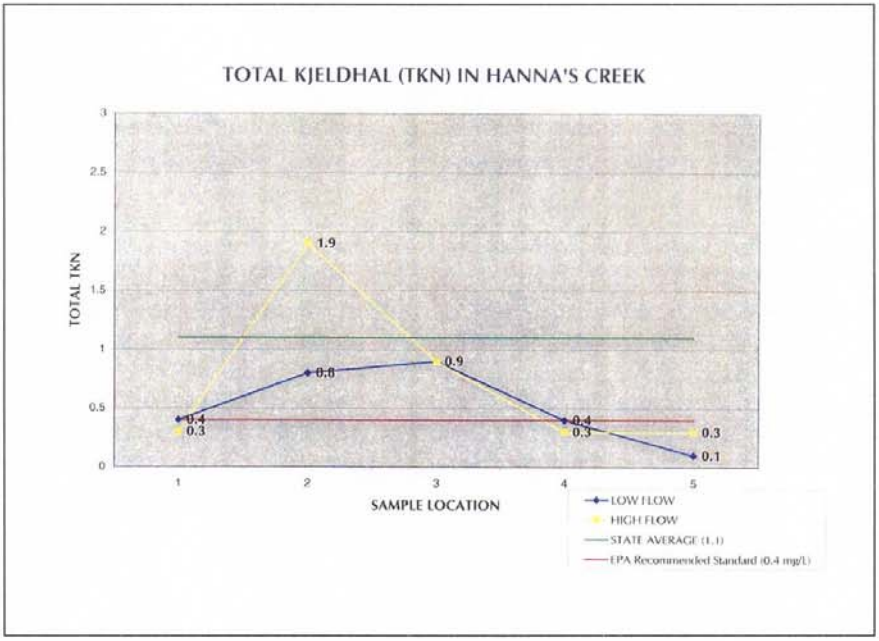


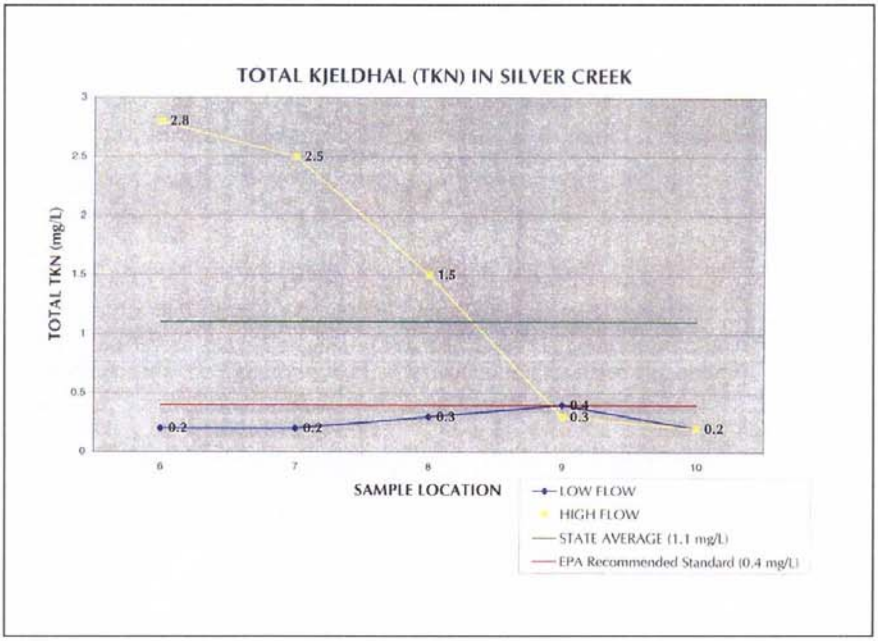


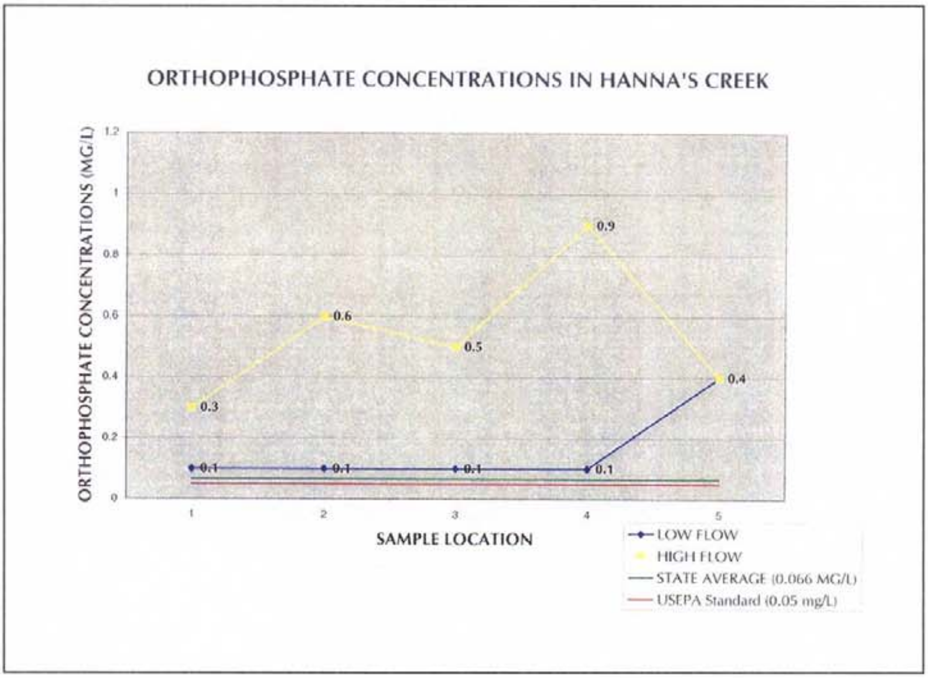
LOW FLOW VS. HIGH FLOW FECAL COLIFORM COUNTS IN HANNA'S CREEK
FECAL COUNT (CFU/100ML)
SAMPLE LOCATION
7,000
10,000
4,000
5,000
6,000
200
180
380
360
230
FECAL COUNT AT LOW FLOW
FECAL COUNT AT HIGH FLOW
EPA Reference (1,000 cfu/100 ml)

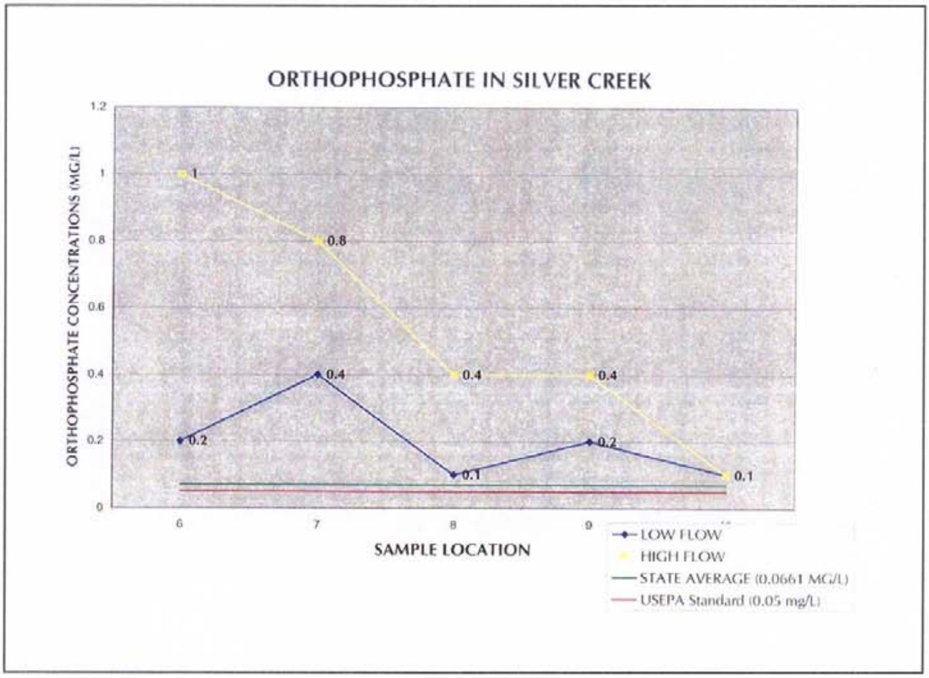


LOW FLOW VS. HIGH FLOW FECAL COLIFORM COUNTS IN SILVER CREEK
FECAL COUNT (cfu/100ml)
SAMPLE LOCATION
50,000
15,000
10,000
6,000
1,900
11,810
500
290
990
8,000
FECAL COUNT AT LOW FLOW
FECAL COUNT AT HIGH FLOW
EPA Refernce (1,000 cfu/100ml)


TOTAL KJELDHAL (TKN) IN HANNA'S CREEK
TOTAL TKN
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
STATE AVERAGE (1.1)
EPA Recommended Standard (0.4 mg/L)


TOTAL KJELDHAL (TKN) IN SILVER CREEK
TOTAL TKN (mg/L)
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
STATE AVERAGE (1.1 mg/L)
EPA Recommended Standard (0.4 mg/L)





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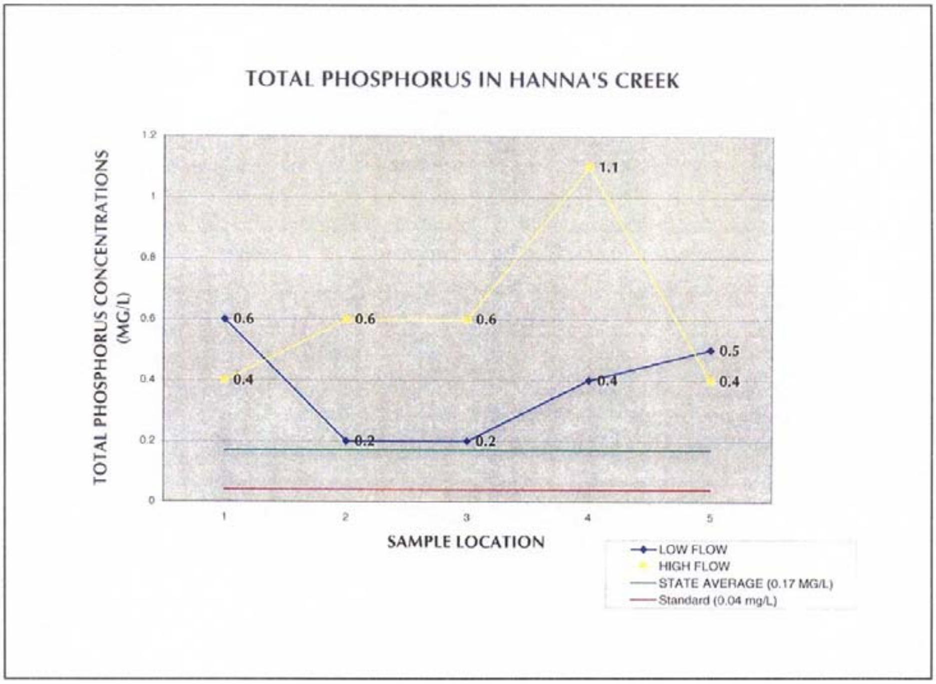
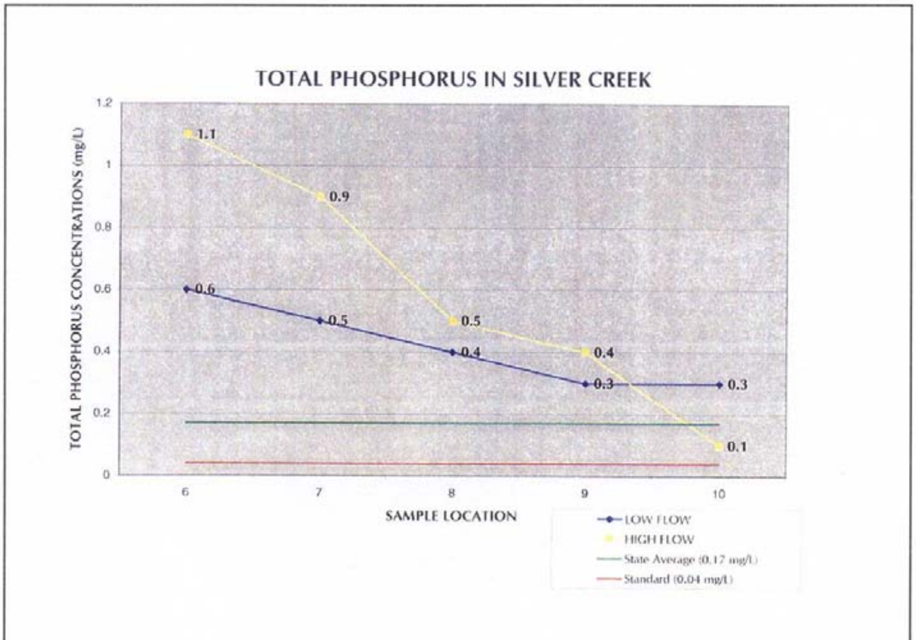
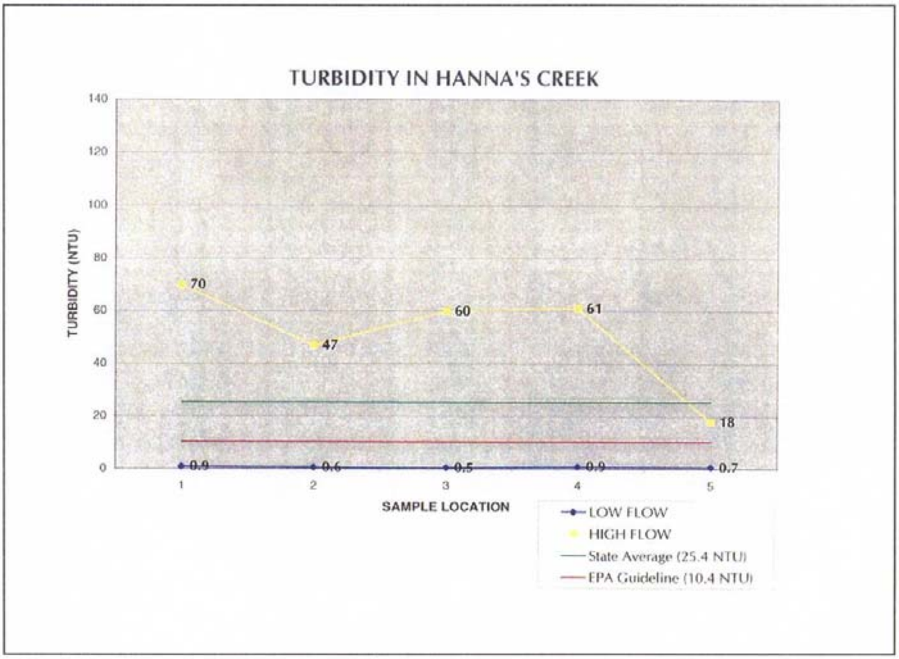
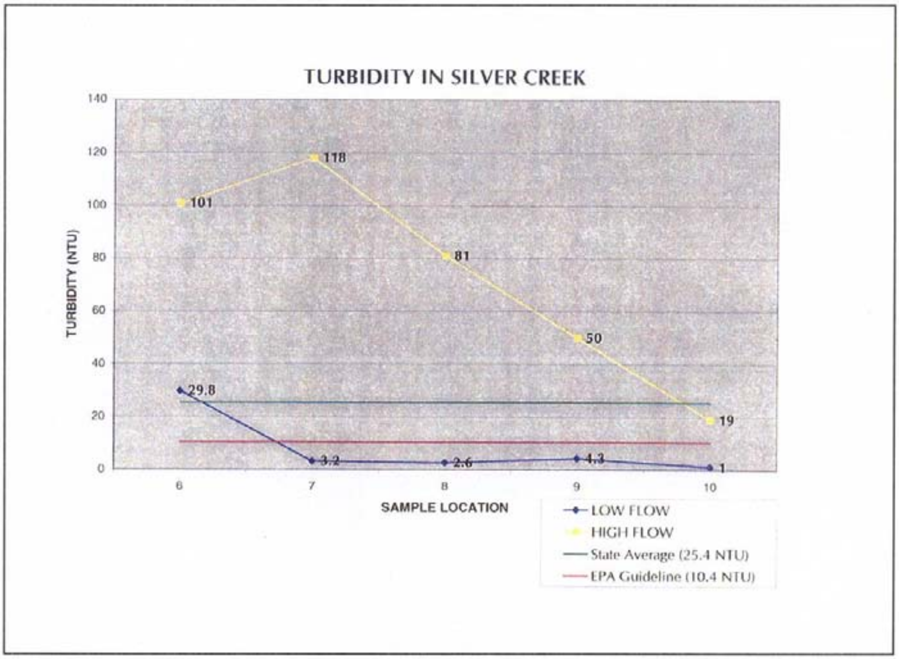

TOTAL PHOSPHORUS IN HANNA'S CREEK
TOTAL PHOSPHORUS CONCENTRATIONS (MG/L)
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
STATE AVERAGE (0.17 MG/L)
Standard (0.04 mg/L)


TOTAL PHOSPHORUS IN SILVER CREEK
TOTAL PHOSPHORUS CONCENTRATIONS (mg/L)
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
State Average (0.17 mg/L)
Standard (0.04 mg/L)


TURBIDITY IN HANNA'S CREEK
TURBIDITY (NTU)
140
120
100
80
60
40
20
0
70
47
60
61
18
0.9
0.6
0.5
0.9
0.7
1
2
3
4
5
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
State Average (25.4 NTU)
EPA Guideline (10.4 NTU)


TURBIDITY IN SILVER CREEK
TURBIDITY (NTU)
140
120
100
80
60
40
20
0
101
118
81
50
19
29.8
3.2
2.6
4.3
1
6
7
8
9
10
SAMPLE LOCATION
LOW FLOW
HIGH FLOW
State Average (25.4 NTU)
EPA Guideline (10.4 NTU)

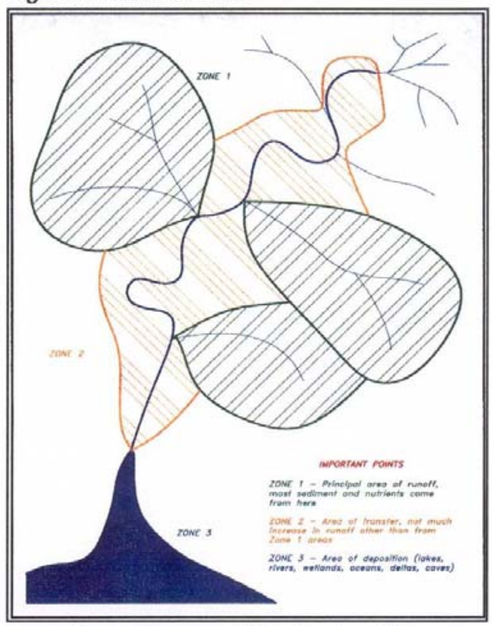
5.0 SEDIMENT LOADING

A review of historic aerial photographs of Whitewater Lake and Brookville Lake has revealed significant changes in shoreline morphology at the points of discharge of Silver Creek and Hanna's Creek, respectively, resulting from sediment loading. Sediment loading is due, in part, to the dynamics of fluvial geomorphology.

5.1 Basic Fluvial Geomorphology

Fluvial geomorphology is the study of river/stream made landforms. It is a dynamic process that is constantly modifying the landscape. The impacts of agriculture, transportation, and urbanization can alter this natural process, in some cases dramatically. Mitigation of these impacts on fluvial systems necessitates a basic understanding of how these systems work.

Figure 6.1. Fluvial Zones



Source: Sagamore Environmental Services, Inc., 2001

Fluvial systems are divided into three distinct zones (Figure 6.1). Zone 1 is the area of runoff. Approximately 85% of the water and sediment moving through a fluvial system enters in Zone 1. Zone 2 is the area of transfer. Zone 3 is the area of deposition. The parts of the landscape represented by each zone are relative to the scale of the project. For example, at a national scale, if Zone 3 represented the Gulf of Mexico, Zone 2 would represent the Mississippi River and the Ohio River would represent Zone 1. At the scale required for sediment mitigation within the watersheds, Zone 1 represents Silver Creek/Hanna's Creek, Zone 2 are the truncated tributaries, and Zone 3 are the subtributaries and intermittent headwaters of the tributaries. As noted earlier, many of the truncated tributaries throughout Union County are buffered; however, a majority of the water and sediment is entering the system upstream. During normal (low flow) conditions, these buffers reduce water velocity from upstream, thus causing water percolation and sediment drop-out. Yet, downstream buffers are unable to handle water volume and velocity during high flow conditions. Water quality data supports this analysis (Chapter 4).

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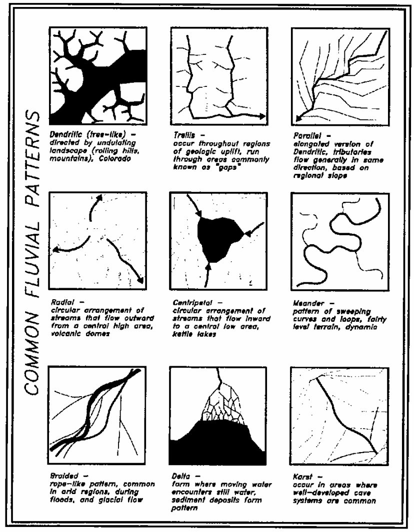
Natural stream meander is also contributing to a portion of the sediment loading. Fluvial systems can take one of, or a combination of, nine major forms (Figure 6.2). These forms dictate how the fluvial system will manipulate the landscape. The form of fluvial system in this area is a combination of meander and parallel. A meander form is a winding channel with several bends. The meander is a result of glacial meltwater of the Wisconsinan Glacial Period carving through soft material in low-lying portions of the landscape. The parallel form is comprised of multiple stream channels running generally parallel with one another, discharging into a common acceptor. This form is the result of a regional slope.

Union County slopes to the southwest, thereby influencing the parallel form. However, the greatest factor dictating fluvial form in this area is glacial activity. Most streams in central Indiana are of the meander form due to the recent glacial period. The meandering form is ever-changing. A bend in a channel is comprised two major components: 1) scour and 2) deposition. The outside of the bend scours or excavates soil from the toe slope of the stream channel and deposits the material on the opposite side of the channel beyond the bend. During periods of high velocity, scoured material can be carried far downstream.

Figure 6.2. Fluvial Forms



Source: Sagamore Environmental Services, Inc.

5.2 Shoreline Morphology

Sediment loading is altering the shoreline and depth at the discharge points of Silver Creek and Hanna's Creek. Eroded and scoured sediment that is transported by the creeks is deposited when stream discharges into the lake, significantly reducing the velocity of the flow. Heavier particles (gravel and sand) drop out first. Finer particles (silt and weathered clay) can cause a sediment plume that extends out into the lake. Shoreline morphology is a study of the change in form of the shoreline in the areas impacted by sedimentation.

5.2.1 Whitewater Lake – Silver Creek

Whitewater Memorial State Park, with its 200-acre lake, was established in 1949. The park is located one mile south of Liberty, Indiana and features a 1/4 mile sandy beach with swimming area (when lifeguards are present),

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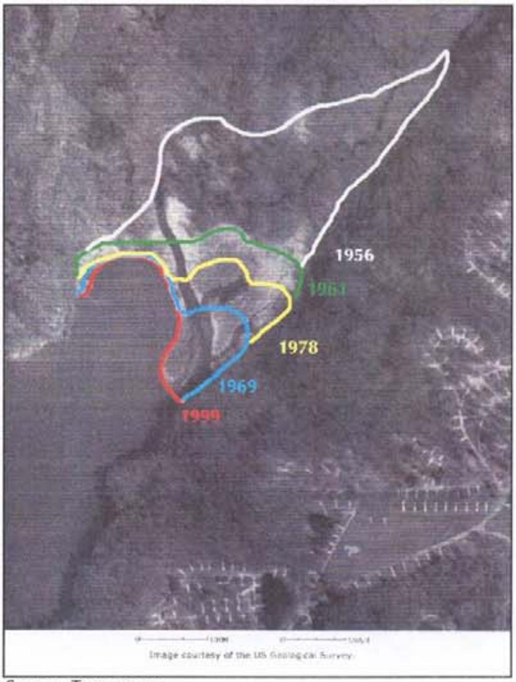
fishing, boating, 20 cabins, picnicking, horse trails, handicapped facilities, sightseeing and camping.

Figure 5.1. Shoreline morphology since 1956



Source: Terraserver

As discussed in section 2.5.1, the annual rate of sediment accumulation in Whitewater Lake has been 357,000 cubic feet per year. Aerial photography from 1956 through 1999 has shown a dramatic change in the shoreline at the Silver Creek discharge. The 1956 photograph shows the closest to the original shoreline of Whitewater Lake. Dredging at this location occurred from 1978 to 1981 and 1984 to 1988. This would account for the shoreline reversion from 1969 to 1978. Since the termination of dredging, the shoreline has continued to encroach on the lake. Figure 5.1 is the 1999 aerial photograph of the northern portion of Whitewater Lake that shows the changes in shoreline over time according to aerial photography. A copy of each aerial photograph is included in Section 5.3.

5.2.2 Brookville Lake – Hanna's Creek

Brookville Lake was constructed on the east fork of the Whitewater River (south of Whitewater State Park) by the U.S. Army Corp Of Engineers. Construction of the lake began in 1965. Impoundment construction began in 1974. The lake is 5260 acres in size and about 16 miles long making it the third largest lake in Indiana. It features a swimming area with beach, boating, fishing, camping, marinas, picnic areas, hunting, scenic drives, walking paths, and food concessions. Brookville Lake is the only lake in Indiana that stocks pure strain Striped Bass and is one of only two lakes stocked with pure strain Muskellunge. Other species include White-Bass, Crappie, Bluegill, Redear, Perch, Channel Catfish, Largemouth Bass, Northern Pike, Walleye, and Rockbass.

The only aerial photography (AP) available for Brookville Lake is 1995 and 1999. However, the amount of sediment loading at the Hanna's Creek discharge is visibly significant in this five-year period. Both the 1995 and

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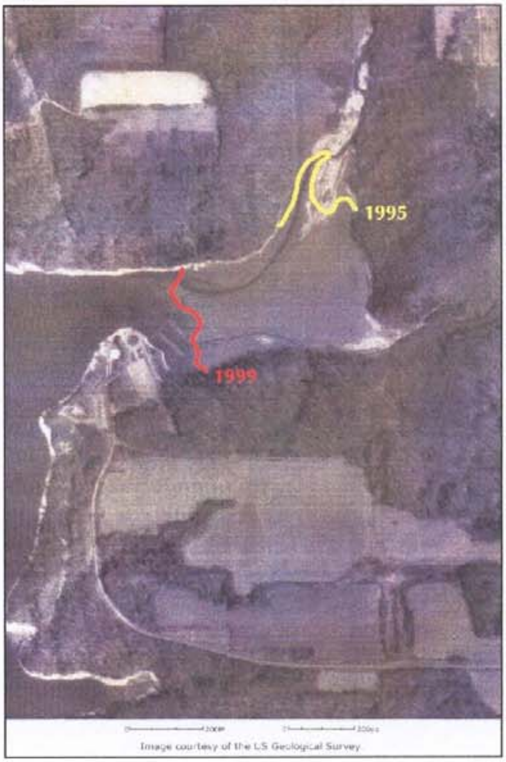
1999 Aps were taken during winter pool (740 feet mean sea level), which is down eight feet from summer pool. This accounts for the amount of exposed shore-line. Sedimentation in this inlet is causing shallow water concerns during summer pool. According to Mr. Robert Felix, Property Manager, IDNR, maintenance on the marina, pictured along the southern portion of the inlet, has been extensive due to sediment loading. There have been complaints from boaters that the marina is becoming inaccessible. Figure 5.2 is the 1999 photograph of the Hanna's Creek discharge inlet that shows the sedimentation from 1995 to 1999. A copy of the aerial photographs is included in Section 5.2.

Figure 5.2: Sediment loading from 1995 to 1999



Source: Terraserver

Based on historic aerial photography, turbidity levels, and flow data, it is apparent that sediment loading is a significant concern in both watersheds. High flow conditions resulted in flow velocities that were more than adequate to not only scour unbuffered toe-slopes along the stream bank, but also significantly increased turbidity measurements. In many cases, sediment loading is indicative of nutrient loading. This is due to nutrients, in the form of fertilizers, binding to soil particles that then erode from fields into streams and lakes. According to Mr. Felix, in his 28 years as property manager, there has been no feedback regarding nutrient loading in either lake. This could be attributed to one of three possibilities: either; (a) there are no nutrient concerns from the streams; (b) nutrients have remained bound to the deposited sediment; or, (c) nutrient concentrations dilute when introduced to the volume of water in the lake.

(a) Based on recent and historic water sampling, turbidity levels and phosphorus, organic nitrogen (TKN) and fecal coliform concentrations are significantly elevated within the streams, particularly during high flow conditions. Therefore, nutrients are being introduced into the lakes along with sediment, so there are nutrient concerns.

(b) If nutrients remain bound to deposited sediment, it can become encapsulated within the sediment load. These nutrients can be released in bursts of high concentration during dredging operations, the effects of which can be evident in algal blooms, odor, and even fish kills. According to Mr. Felix, there were no signs of nutrient concentration issues during the dredging operations at Whitewater Lake. Therefore, though it is highly likely that nutrients have remained bound to the deposited sediment, it does not appear to be problematic.

(c) Dilution appears to be the most probable nutrient mitigation scenario occurring within these lakes. However, the ever-encroaching shorelines are reducing the volume of each lake. With a reduction in total volume, dilution becomes less effective. Therefore, the current sedimentation dynamic is introducing nutrients, causing shoreline encroachment, reducing lake volume, and may be impeding nutrient dilution.

5.3. Historic Aerial Photography

Historic aerial photography of the watersheds was reviewed at the Indiana State Archives (1956, 1961 and 1969), the Indiana State Land Office (1974 and 1995), the Union County Natural Resource Conservation Service (1981), and online at http://terraserver.homeadvisor.msn.com (1999). These photographs provided an account of changes within the lakes as well as the watersheds. The following aerial photographs document the impact of sediment loading in Whitewater Lake and Brookville Lake.

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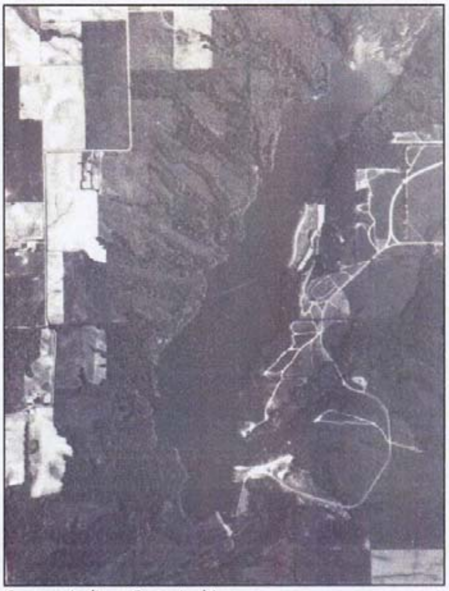
Figure 5.3. Historic Aerials of Whitewater Lake

1956: Note original shoreline

Source: Indiana State Archives

1961: Significant sediment loading



Source: Indiana State Archives

1969: Note sediment plume

Source: Indiana State Archives

1974: Dredging reverses sedimentation

Source: Indiana State Land Office

1981: Sediment plume measured 2,200 feet

Source: Union County NRCS

1999: Loading continues after dredging ceased

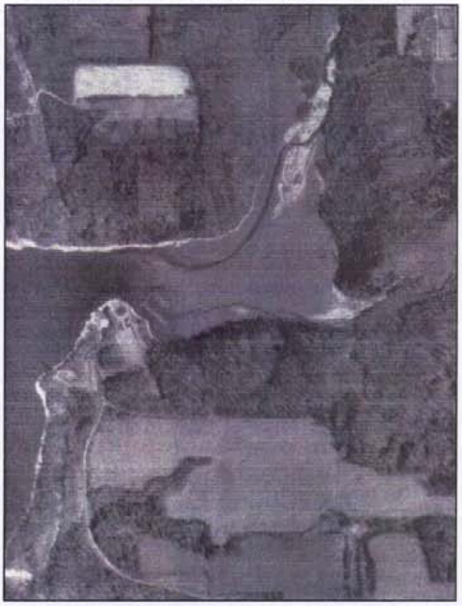
Source: http://terraserver.homeadvisor.msn.com

Figure 5.4. Historic Aerials of Brookville Lake

1995: Loading at Hanna's Creek discharge

Source: Indiana State Land Office

1999: Sediment encroaching on marina



Source: http://terraserver.homeadvisor.msn.com

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6.0 PUBLIC RELATIONS

Community involvement is essential to a successful watershed management program. Every effort was taken to involve the residents of Union County throughout the watershed diagnostic study. The Union County SWCD played an integral part in the study. Input and involvement from the board and the Union County Natural Resources Conservation Service was employed from the beginning.

The district board meets the third Tuesday of every month, barring holidays and community events. The board is comprised of Union County residents from a variety of backgrounds. Representatives from Sagamore attended most of these meetings throughout the study. The board was kept abreast of the progress of the study throughout its duration. On multiple occasions, members of the board participated in field activities.

Sagamore completed a brochure to promote public awareness. The brochure was distributed via mail to individuals on the mailing list of the soil and water conservation board. A copy of this brochure is included in Appendix O.

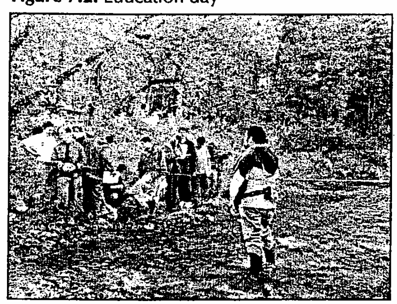
Sagamore along with members of the SWCD coordinated two community meetings. The initial public meeting was designed to explain the diagnostic study, to reveal information gathered during the preliminary review, and to discuss the field work activities. There were approximately 90 people in attendance at the initial meeting. The results, conclusions, and recommendations of the diagnostic study were presented at the second community meeting. There were over 110 persons who attended the second meeting. Local newspapers provided advertising for and editorials of each meeting.

Figure 7.1. Media coverage examples

Sources: Liberty Herald, Palladium Item, The Examiner

In addition, an education day was coordinated and facilitated by Sagamore and the Union County SWCD. Twenty-seven students from the Union County Middle School learned about watershed dynamics. They also had the opportunity to perform some water quality analysis with field instrumentation, sample and identify benthic macro-invertebrates, assess habitat characteristics, and discuss human impacts and conservation.

Figure 7.2. Education day



Photograph taken October 11, 2001

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7.0 CONCLUSIONS AND RECOMMENDATIONS

Effective watershed management is facilitated by two factors: 1) public involvement, and 2) a comprehensive plan. Therefore, Sagamore recommends that the Union County SWCD, in cooperation with the residents of Union County, facilitate the assembly of a watershed partnership and the drafting of a watershed management plan. Funding for this type of endeavor is available through the USEPA Section 319 Program, facilitated by IDEM.

A watershed management plan will not only prioritize and detail mitigation projects, but will also establish guidelines for future development and land use practices within the watersheds. Information provided within this report be can used in the composition of a management plan.

7.1 Significant Issues

Based on data collected during this watershed diagnostic study, there are three significant issues within the Silver Creek and Hanna's Creek watersheds. They are prioritized as 1) Sediment, 2) Fecal Material, and 3) Phosphorous. A map of the prioritized subsections is included in Attachment 7.1.

7.1.1 Sediment

As discussed in Chapter 5.0, sediment loading is a major concern at both Whitewater Lake and Brookville Lake. Sediment loading reduces the overall acreage, depth, and volume of a lake, alters aquatic habitat, and can introduce high concentrations of nutrients bound to soil particles. Flow monitoring revealed velocities well above that necessary for transport and scour of soil particles (Section 4.2). In response to sediment loading, dredging operations occurred at the discharge of Silver Creek into Whitewater Lake from 1978 to 1981 and 1984 to 1988. However, aerial photography has revealed that since the termination of dredging operations, the shoreline has continued to encroach on Whitewater Lake due to sedimentation. Likewise, Hanna's Creek has altered the shoreline and reduced the depth of Brookville Lake at its point of discharge.

Whitewater Lake and Brookville Lake are both public, recreational lakes with boating, fishing, and swimming. Water quality in these lakes is a concern for not only aquatic habitat and human contact, but also economics as well. Tourism at these lakes accounts for a significant portion of the economy of Liberty and all of Union County. Degradation of water quality would have not only ecological and human health effects, but also the livelihood of residents depending on seasonal tourism would be dramatically impacted as well.

Sagamore recommends mitigation of sediment loading as the highest priority within the watersheds. Mitigation recommendations are two-fold: 1) reducing the amount of sediment entering the streams; and, 2) trapping sediment prior to its entering the lakes.

7.1.1.1 Sediment Reduction

Reducing the amount of sediment entering the streams will be the function of best management practices (BMPs) and streambank stabalization. BMPs are prevalent throughout Union County. Grassed waterways and riparian buffers are employed along the streams and truncated portions of tributaries; however, a majority of the headwaters of these tributaries are unbuffered. Also, natural stream meander is causing significant scour throughout the watersheds.

Mitigation of natural erosion processes is not always necessary. This is because erosion caused by natural meander is usually negligible. Unfortunately, not all streambank erosion is caused by natural processes. Sample location 6 is at a horse crossing on Silver Creek on the property of the Whitewater State Memorial Park (Figure 7.3). The stream-banks on both sides of the stream at this location have been degraded. The stream channel along this location has a deep layer of silt (36 inches deep in some places). The stream banks at this location should be stabilized and a bridge constructed for horse crossing.

Figure 7.3. Sample Location 6

Photograph taken May 17, 2001

7.1.1.2 Sediment Trapping

The discharge points of each stream flow though palustrine, forested wetlands. These wetlands should be enhanced to increase water exposure gradually over a larger area. Sediment basins are recommended upstream of the wetland enhancement. Sediment basins are high maintenance, but would serve to trap significant amounts of sediment until more BMPs and the wetland enhancement are implemented. Funding for BMPs can be provided in part by the LARE program on a cost-share basis. Projects (including funding) on state property must be coordinated by the Union County SWCD, the IDNR, and the property management personnel at Brookville Lake.

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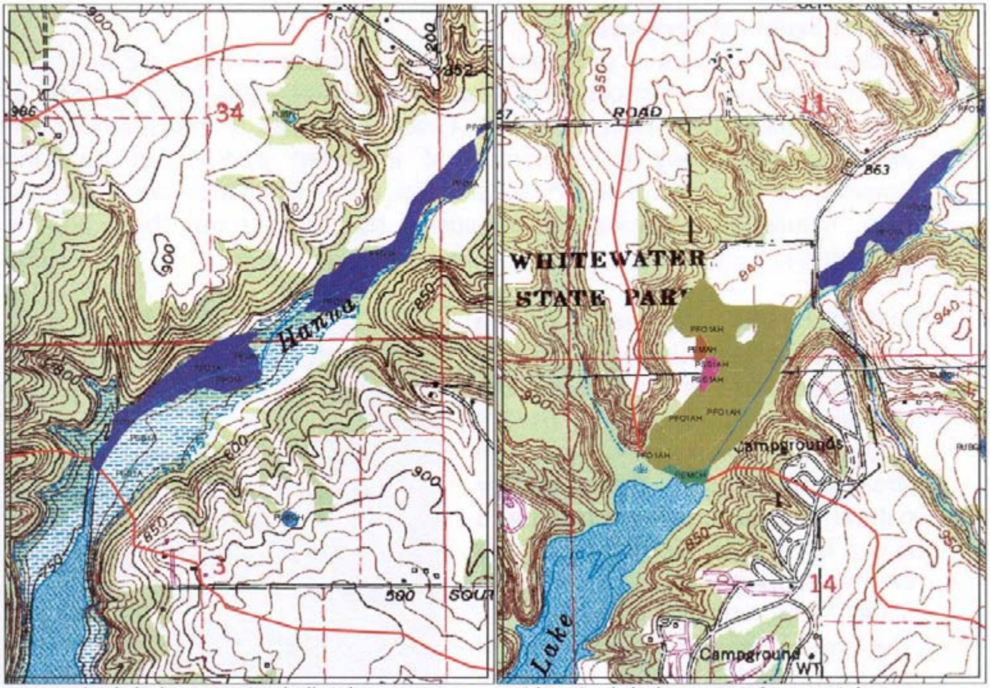
Figure 7.4. Potential wetland enhancement locations at discharge points of creeks into lakes



Hanna's Creek discharge into Brookville Lake | *Silver Creek discharge into Whitewater Lake*

7.1.2 Fecal Material

Potential sources of fecal material entering the watersheds have been observed during the site reconnaissance and water quality analysis (fecal coliform and TKN). Issues concerning fecal material include the following: 1) the untreated discharge of sewage and urban runoff during high flow conditions; 2) high amounts of observed manure at sample location 6 (horse crossing); 3) livestock operations throughout the watersheds that allow livestock direct access to tributaries; 4) runoff from fields utilizing untreated organic fertilizers; and, 5) potential impacts from septic systems.

7.1.2.1 Urban Wastewater

The Town of Liberty has a 0.43 million gallon per day, Class II contact stabilization/extended aeration plant with pressurized rapid sand filter tanks, phosphorous removal, and chlorination facilities. The Liberty sewer system is a separate storm system and sanitary system by design. Overflow or bypass points present in the sanitary sewer system or at the wastewater treatment facility are expressly prohibited from discharging at any time. Should any discharge occur, the permittee is required to notify the IDEM, Office of Water Management, Enforcement Section within 24 hours and in writing within five

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days of the event. Such discharge events are considered to be permit violations. Incidents of bypass/overflow and warnings of noncompliance are on file with IDEM for the Liberty WWTP.

The WWTP is under the Lake Discharger Policy (USEPA) due to its proximity to Whitewater Lake. Bypass and elevated constituent incidents may be caused by blockage, equipment failure, or improperly managed precipitation. Fecal coliform and TKN concentrations increased significantly downstream of the WWTP discharge tributary during the high flow event (Table 5.10). This may be due to urban fauna wastes being delivered unattenuated through the urban stormwater system. In response, wetland biofiltration is recommended along the discharge tributary. Wetland biofiltration would provide exposure of untreated wastewater to appropriate microbiological activities to mitigate elevated constituent concentrations in the event of a bypass/system failure event. Funding for this mitigation activity is available from the IDNR, LARE program.

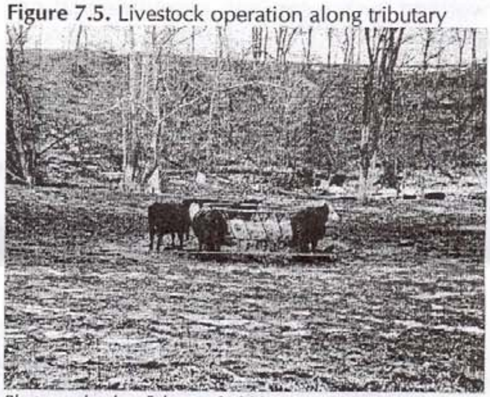
7.1.2.2 Horse Crossing

Horse droppings were observed on both sides of the horse crossing on Silver Creek, sample point 6. Laboratory analysis revealed the highest fecal coliform and TKN concentrations downstream from this site (Table 5.10). Previous recommendations call for the construction of a bridge and streambank restoration/stabilization at this site. It is also recommended that state property management personnel remove and properly dispose of excess manure from the site. The previous wetland enhancement recommendations will serve to mitigate fecal coliform and TKN concentrations.

7.1.2.3 Livestock Operations

Livestock operations that allow livestock direct access to tributaries were noted throughout the watersheds. Livestock have a dramatic effect on stream quality. Denuded pastures have no way of stabilizing soil or retarding runoff. Laboratory analysis revealed significantly elevated fecal coliform and TKN concentrations downstream from these sites during both high and low flow events. Livestock BMPs are recommended for these facilities. Also, the SWCD is recommended to encourage landowners to work with the IDEM Manure Management Program. The previous wetland enhancement recommendations will serve to mitigate fecal coliform and TKN concentrations.

Figure 7.5. Livestock operation along tributary



Photograph taken February 2, 2001

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7.1.2.4 Organic Fertilizers

Organic fertilizers were not sampled or inventoried as part of this study; however, runoff from agricultural lands upon which untreated organic fertilizers have been applied can deliver fecal coliforms to the downstream watershed. A watershed management plan will best serve as a platform for initiating organic fertilizer awareness within the watersheds.

7.1.2.5 Septic Systems

Septic systems were not sampled or inventoried as part of this study; however, a majority of the homes in the watershed study area are on septic, including much of the development around Liberty. It is recommended that the Union County SWCD partner with the Union County Health Department and the County Planning Commission to educate residents on the concerns regarding septic systems and proper management of existing systems. A watershed management plan will best serve as a platform for initiating septic awareness within the watersheds.

7.1.3 Phosphorous

Elevated phosphorous (total and ortho) levels were observed at each sample location during both high and low flow events. This is most likely due to previously mentioned buffering issues. Therefore, ongoing BMP efforts are recommended to mitigate the elevated phosphorous levels. Reducing the amount of excess phosphorous that becomes runoff would dramatically reduce the phosphorous concentrations in the streams. Nutrient management is recommended to determine phosphorous requirements in the soil per respective crop throughout the watersheds. The wetland enhancement recommendations will serve to mitigate phosphorous concentrations.

7.2 Proposed Project Prioritization

The following prioritized recommendations are made in response to the previously discussed issues:

1. Best Management Practices (BMPs) – The Union County SWCD has made an effective effort to promote BMPs throughout the county. Thus far, these efforts have been successful. It is recommended that the SWCD, in cooperation with the NRCS, continue these efforts onto remaining, non-buffered tributary headwaters. Those areas that remain non-buffered are few and are distributed throughout the watersheds. Also, greater efforts to promote BMPs on more livestock operations throughout the watersheds should be expedited. There are several livestock operations within the watersheds, encompassing approximately 6,000 linear feet of tributaries, that could benefit from BMPs. These types of conservation practices mitigate sediment and nutrient loading at the point of runoff. Cost/benefit

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details of several BMPs are included in Appendix E. Actual costs and timelines for implementation of BMPs are dependent upon the most appropriate BMP per site, current condition of respective sites, current use of respective sites, and cooperation of landowners. Funding for BMP work is available through the LARE program.

2. Biofiltration of the tributary that discharges from the WWTP - The "un-named tributary" (as called by IDEM) that flows from the WWTP is approximately one-quarter of a mile long, is narrow, and runs fairly straight. An aggressive step-down series of settling basin/biofiltration wetlands is recommended to mitigate effluent that may discharge from the facility. The cost of this project is dependent upon physical characteristics along the stream channel in relation to engineering requirements of such an endeavor. Timeline is most dependent on landowner cooperation. Funding for this work is available through the LARE program.

3. Sediment basins - In response to the immediate sediment loading concern in Whitewater Lake and Brookville Lake, sediment basins are recommended upstream from the discharge point of the creeks. The basins will be designed to be a temporary mitigation of sediment loading until Recommendation 1 and Recommendation 4 can be implemented. If designed properly, by the time the basins fill with sediment, the other recommended projects will be functioning; therefore, the basins will not require dredging. Once filled, they can be abandoned in place. If future land use changes occur that increase sediment loading beyond what the permanent responses (Recommendations 1 and 4) can mitigate, the basins structures will already be in place and will simply require dredging to be operable. The cost of these sediment basins will be dependent on detailed soil loss calculations proportional to anticipated implementation of Recommendations 1 and 4. This information, coupled with on site characteristics of proposed locations (feasibility study), will determine the appropriate types and sizes of structures. Timeline for this project is dependent on availability of funding and information gathered during feasibility studies; yet, should take approximately eight months to plan and install. These basins will be located on property controlled by the State of Indiana; therefore, funding for this recommendation needs to be coordinated with the State.

4. Wetland enhancement – The points where Silver Creek and Hanna's Creek discharge into Whitewater Lake and Brookville Lake are forested, palustrine wetlands (Figure 7.4). However, the stream channels are so furrowed that even during high flow conditions the water does not get much exposure to the wetlands. It is recommended that these wetland areas be graded to form a "delta-like" landform. Dispersing the water over a larger area will increase exposure to microbiological activity (mitigation

of nutrient loading) and distribute sediment drop-out. If the previously mentioned BMPs are successful in reducing the amount of sediment entering the creeks, the widespread dispersion of the remaining sediment in a delta landform, with minimal maintenance, will create a sustainable morphological dynamic. As sediment is deposited throughout the area, stream flow will be subtly diverted causing a random deposition/stream channel creation dynamic that will provide long-term mitigation. The cost of this project will be dependent on site characteristic information gathered from an engineering feasibility study. The amount of time required to implement this project is also dependent on site specific information. These enhancements will be located on property controlled by the State of Indiana; therefore, funding for this recommendation needs to be coordinated with the State.

5. Horse trail remediation – The stream bank at the point where the horse trail crosses Silver Creek in Whitewater State Memorial Park has been decimated (see Figure 7.3). A large amount of sediment is entering the stream at this point. Also, significant amounts of horse droppings were observed at the crossing. Laboratory analysis revealed the highest fecal coliform concentrations at sample location 6, immediately downstream of this area. Approximately 45 linear feet of stream bank restoration is recommended for this site. In addition, a bridge is recommended for the horse crossing to protect the bank. Finally, manure that accumulates in this area should be removed and properly disposed. The cost of this project will be dependent on a restoration design and bridge type decided on by the property management personnel for Whitewater State Park. Regardless of the applied technology, the bridge construction should precede and stream bank restoration. These projects can run consecutive and should be able to be planned and implemented in 12 months. This project will be located on property controlled by the State of Indiana; therefore, funding for this recommendation needs to be coordinated with the State.

7.3 Future Work

Sagamore recommends that a watershed partnership be organized for the purpose of community-lead watershed management of Silver Creek and Hanna's Creek. The partnership should include a cross sectional representation of Union County. The partnership should serve to guide management of resources within the watersheds, facilitate volunteer monitoring, represent natural resources concerns to political interests in Union County, and educate residents of the importance of resource management. A watershed management plan should be drafted to provide guidance and direction for management initiatives. The plan should document the current state of the watersheds and provide practical solutions for future issues in the county that have the ability to impact water and habitat quality. Funding for this type of activity is available from the USEPA 319 Grant Program, facilitated by IDEM.

ATTACHMENT

7.1. Map of Prioritized Watershed Subsections

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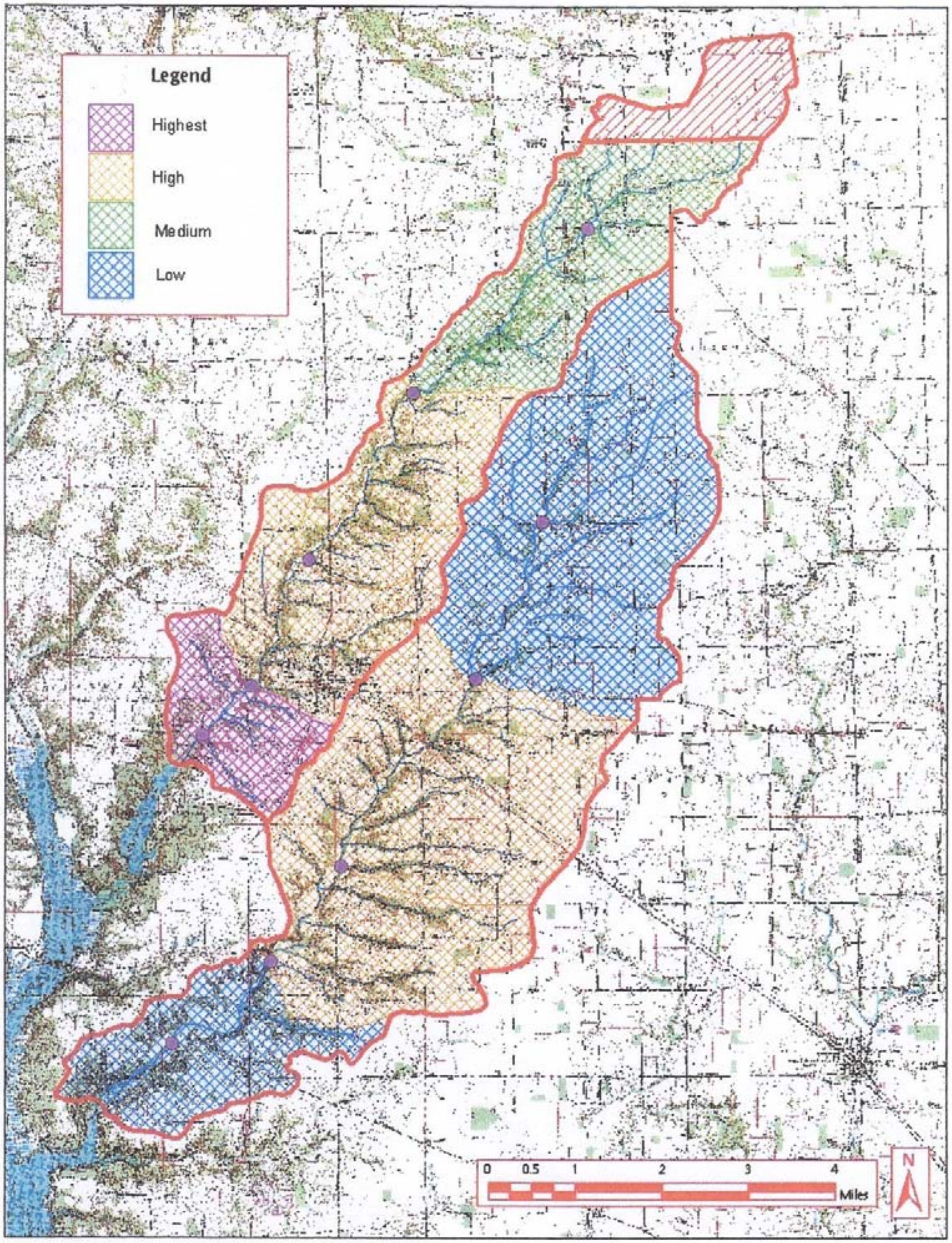
Attachment 7.1. Prioritized watershed subsections



Appendices

APPENDIX A

Wetland Code Definitions

Wetland code definitions

System

[P] Palustrine: The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas when salinity due to ocean derived salts is below 0.5 parts per ton (ppt). Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 20 acres; 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 6.6 feet in the deepest part of the basin; and, 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

All water bodies visible on the aerial photography that are less than 20 acres in size are considered to be in the Palustrine System unless depth information is available, or unless an active wave-formed or bedrock shoreline feature is visible.

The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.

[R] Riverine: The Riverine System includes all wetlands and deepwater habitats contained in natural or artificial channels periodically or continuously containing flowing water or which forms a connecting link between two bodies of standing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System. This system is bound on the landward side by upland, by the channel bank (including natural and man-made levees), or by wetlands dominated by trees, shrubs, persistent emergents, mosses, or lichens. In braided streams, the system is bounded by the banks forming the outer limits of the depression within which the braiding occurs. The Riverine System terminates at the downstream end where the channel enters a lake. It terminates at the upstream end where tributary streams originate, or where the channel leaves a lake. Springs discharging into a channel are considered part of the Riverine System.

Where a river enters a lake, the extension of the Lacustrine shoreline across the mouth of the river forms the Riverine /Lacustrine break. Oxbow lakes are placed in the Palustrine or Lacustrine Systems unless they are connected to a Riverine System by an open channel at both ends either permanently or intermittently. Run-of-the-river dams should be handled in the same manner as described above, with the Lacustrine System extending upstream to the contour approximating the normal spillway or pool elevation. The USGS maps or USGS Water Resources Data (stream gauge data) are used as the primary data source in determining if the riverine channel is a perennial or intermittent stream.

Subsystem

(2) Lower Perennial: This Subsystem is characterized by a low gradient and slow water velocity. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud. The floodplain is well developed. Oxygen deficits may sometimes occur.

Class

Class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the ***substrate***. Life forms (e.g. trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

Substrate – any earthen layer below the O, A, E, and B diagnostic soil horizons

[FO] Forested: Characterized by woody vegetation that is six meters tall or taller. All water regimes are included except subtidal.

[SS] Scrub-Shrub: Includes areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. All water regimes, except subtidal, are included.

> (1) Broad-leaved Deciduous: Woody angiosperms (trees or shrubs) with relatively wide, flat leaves that are shed during the cold or dry season; e.g., black ash (Fraxinus nigra). Associated with FO and SS.

[EM] Emergent: Characterized by erect, rooted, herbaceous ***hydrophytes***, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Hydrophytes – water-loving plants

[UB] Unconsolidated Bottom: Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Water regimes are restricted to the following: subtidal, permanent-tidal, semipermanent-tidal, permanently flooded, intermittently flooded, and semipermanently flooded.

[US] Unconsolidated Shore: Includes all wetland habitats having three characteristics:

(1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock;
(2) less than 30% areal cover of vegetation other than pioneering plants; and
(3) any of the following water regimes: a) irregularly exposed, regularly flooded; b) irregularly flooded, seasonally flooded; c) temporarily flooded, intermittently flooded; d) saturated, seasonal-tidal, temporary-tidal; e) or artificially flooded.

Water Regime: Freshwater Non-Tidal areas (L, P, and R systems)

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or ***seiches*** in lakes. Water regimes are defined in terms of the growing season, which we equate to the frost-free period. The rest of the year is defined as the dormant season, a time when even extended periods of flooding may have little influence on the development of plant communities.

Seiches - free oscillation of water in a closed or semi-closed basin

[A] Temporarily Flooded: Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

[C] Seasonally Flooded: Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

[D] Seasonally Flooded/Well Drained: Similar to "seasonally flooded", with a well drained (usually sandy) substrate.

[F] Semipermanently Flooded: Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

[G] Intermittently Exposed: Surface water is present throughout the year except in years of extreme drought.

[H] Permanently Flooded: Water covers the land surface throughout the year in all years.

APPENDIX B

Hydric Soils List for Union County

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
A.	These units are dominated by components that meet the hydric soil criteria							
Br	BROOKSTON SILT LOAM	Brookston	Depressions and potholes	yes	yes	no	yes	no
By	BROOKSTON SILTY CLAY LOAM	Brookston	Depressions and potholes	yes	yes	no	yes	no
Co	COPE SILT LOAM	Cope silt loam	Depressions and drainageways	yes	yes	no	yes	no
Cp	COPE SILTY CLAY LOAM	Cope silty clay loam	Depressions	yes	yes	no	yes	no
Ko	KOKOMO SILTY CLAY LOAM	Kokomo	Depressions and potholes	yes	yes	no	yes	no
Sn	SLOAN SILT LOAM	Sloan	Flood plains	yes	yes	no	yes	no
We	WESTLAND SILT LOAM	Westland	Depressions	yes	yes	no	yes	no
B.	These units typically have components that meet the hydric soil criteria							
AvA	AVONBURG SILT LOAM, 0 TO 2 PERCENT SLOPES	Clermont	Center of flats	yes	yes	no	yes	no
AvB2	AVONBURG SILT LOAM, 2 TO 6 PERCENT SLOPES, ERODED	Wakeland	Drainageways	no	no	yes	yes	no
BbA	BIRKBECK SILT LOAM, 0 TO 2 PERCENT SLOPES	Poorly drained aquolls	Depressions	yes	yes	no	yes	no
BbB1	BIRKBECK SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
BbB2	BIRKBECK SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
CrA	CROSBY SILT LOAM, 0 TO 2 PERCENT SLOPES	Poorly drained aquolls	Depressions and potholes	yes	yes	no	yes	no
CrB1	CROSBY SILT LOAM,	Poorly drained	Drainageways	yes	yes	no	yes	no

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table H

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	aquolls	and depressions					
CrB2	CROSBY SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
De	DELMAR SILT LOAM	Poorly drained aquolls	Depressions	yes	yes	no	yes	no
Ee	EEL LOAM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Es	EEL SILT LOAM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
FcA	FINCASTLE SILT LOAM, 0 TO 2 PERCENT SLOPES	Poorly drained aquolls	Depressions and potholes	yes	yes	no	yes	no
FcB1	FINCASTLE SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
FcB2	FINCASTLE SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
FeA	FINCASTLE AND CROSBY SILT LOAMS, 0 TO 2 PERCENT SLOPES	Poorly drained aquolls	Drainageways, potholes, and depressions	yes	yes	no	yes	no

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
FeB	FINCASTLE AND CROSBY SILT LOAMS, 2 TO 6 PERCENT SLOPES	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
FeB2	FINCASTLE AND CROSBY SILT LOAMS, 2 TO 6 PERCENT SLOPES, ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
FeB2	FINCASTLE AND CROSBY SILT LOAMS, 2 TO 6 PERCENT SLOPES, ERODED	Poorly drained aquolls	Drainageways and swales	yes	yes	no	yes	no
Ge	GENESEE FINE SANDY LOAM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Gg	GENESEE GRAVELLY LOAM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Gm	GENESEE LOAM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Go	GENESEE LOAM, HIGH BOTTOM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Gs	GENESEE SILT LOAM	Sloan	Base of adjacent hillslopes	yes	yes	no	yes	no

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
			and abandoned channels					
Gt	GENESEE SILT LOAM, HIGH BOTTOM	Sloan	Base of adjacent hillslopes and abandoned channels	yes	yes	no	yes	no
Ho	HOMER SILT LOAM	Westland	Drainageways and depressions	yes	yes	no	yes	no
MmB1	MIAMI SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmB2	MIAMI SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmC1	MIAMI SILT LOAM, 6 TO 12 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmC2	MIAMI SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmD1	MIAMI SILT LOAM, 12 TO 18 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmD2	MIAMI SILT LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MmE1	MIAMI SILT LOAM, 18 TO 25 PERCENT SLOPES, SLIGHTLY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
MmE2	MIAMI SILT LOAM, 18 TO 25 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MsB3	MIAMI SOILS, 2 TO 6 PERCENT SLOPES, SEVERELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MsC3	MIAMI SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MsD3	MIAMI SOILS, 12 TO 18 PERCENT SLOPES, SEVERELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
MsE3	MIAMI SOILS, 18 TO 25 PERCENT SLOPES, SEVERELY ERODED	Poorly drained aquolls	Drainageways	yes	yes	no	yes	no
ReA	REESVILLE SILT LOAM, 0 TO 2 PERCENT SLOPES	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
ReA2	REESVILLE SILT LOAM, 0 TO 2 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
ReB2	REESVILLE SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	Poorly drained aquolls	Drainageways and depressions	yes	yes	no	yes	no
Sh	SHOALS SILT LOAM	Sloan	Base of adjacent hillslopes and depressions	yes	yes	no	yes	no
WhA	WHITAKER SILT LOAM, 0 TO 2 PERCENT SLOPES	Westland	Drainageways and depressions	yes	yes	no	yes	no
WhB	WHITAKER SILT LOAM, 2 TO 6 PERCENT SLOPES	Westland	Drainageways and depressions	yes	yes	no	yes	no

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

				Hydric Soil Component				
Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
C.	These units typically do not have components that meet the hydric soil criteria							
Bp	BORROW PITS	On-site investigation needed						
CcB1	CINCINNATI SILT LOAM 2 TI 6 PERCENT SLOPE SLIGHTLY ERODED	None						
CcB2	CINCINNATI SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
CcC1	CINCINNATI SILT LOAM, 6 TO 12 PERCENT SLOPES, SLIGHTLY ERODED	None						
CcC2	CINCINNATI SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
CcD1	CINCINNATI SILT LOAM, 12 TO 18 PERCENT SLOPES, SLIGHTLY ERODED	None						
CcD2	CINCINNATI SILT LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
CcE1	CINCINNATI SILT LOAM, 18 TO 25 PERCENT SLOPES, SLIGHTLY ERODED	None						
CcE2	CINCINNATI SILT LOAM, 18 TO 25 PERCENT SLOPES, MODERATELY ERODED	None						
CcF2	CINCINNATI SILT LOAM, 25 TO 45 PERCENT SLOPES, ERODED	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
CnC3	CINCINNATI SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
CnD3	CINCINNATI SOILS, 12 TO 18 PERCENT SLOPES, SEVERELY ERODED	None						
CnE3	CINCINNATI SOILS, 18 TO 25 PERCENT SLOPES, SEVERELY ERODED	None						
FaB	FAIRMOUNT SILTY CLAY LOAM, 2 TO 6 PERCENT SLOPES	None						
FaC	FAIRMOUNT SILTY CLAY LOAM, 6 TO 12 PERCENT SLOPES	None						
FaD	FAIRMOUNT SILTY CLAY LOAM, 12 TO 18 PERCENT SLOPES	None						
FaE	FAIRMOUNT SILTY CLAY LOAM, 18 TO 25 PERCENT SLOPES	None						
FaF	FAIRMOUNT SILTY CLAY LOAM, 25 TO 35 PERCENT SLOPES	None						
FaG	FAIRMOUNT SILTY CLAY LOAM, 35 TO 50 PERCENT SLOPES	None						
FmA	FOX LOAM, 0 TO 2 PERCENT SLOPES	None						
FmB1	FOX LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
FmB2	FOX LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
FmC2	FOX LOAM, 6 TO 12 PERCENT SLOPES,	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Hydric Soil Component: Location of Hydric Soil Component	Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	MODERATELY ERODED							
FnA	FOX SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
FnB1	FOX SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
FnB2	FOX SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
FnC2	FOX SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
FnD1	FOX SILT LOAM, 12 TO 18 PERCENT SLOPES, SLIGHTLY ERODED	None						
FnD2	FOX SILT LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
FoB2	FOX SILT LOAM, KAMES, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
FoC2	FOX SILT LOAM, KAMES, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
FpC3	FOX SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
FrC3	FOX SOILS, KAMES, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
FsD2	FOX AND RODMAN	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	LOAMS, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED							
FtD2	FOX AND RODMAN LOAMS, KAMES, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
FtE2	FOX AND RODMAN LOAMS, KAMES, 18 TO 25 PERCENT SLOPES, MODERATELY ERODED	None						
FvD3	FOX AND RODMAN SOILS, 12 TO 18 PERCENT SLOPES, SEVERELY ERODED	None						
FxD3	FOX AND RODMAN SOILS, KAMES, 12 TO 18 PERCENT SLOPES, SEVERELY ERODED	None						
Gv	GRAVEL PITS	On-site investigation needed						
HeF1	HENNEPIN LOAM, 25 TO 35 PERCENT SLOPES, SLIGHTLY ERODED	None						
HeF2	HENNEPIN LOAM, 25 TO 35 PERCENT SLOPES, MODERATELY ERODED	None						
HeG1	HENNEPIN LOAM, 35 TO 50 PERCENT SLOPES, SLIGHTLY ERODED	None						
HeG2	HENNEPIN LOAM, 35 TO 50 PERCENT SLOPES, MODERATELY	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Hydric Soil Component: Location of Hydric Soil Component	Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	ERODED							
La	LAKE BEACH	None						
Ma	MADE LAND	None						
MbA	MANLOVE SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
MbB1	MANLOVE SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
MbB2	MANLOVE SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
McA	MARTINSVILLE SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
McB1	MARTINSVILLE SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
McB2	MARTINSVILLE SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
McC2	MARTINSVILLE SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
McD2	MARTINSVILLE SILT LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
MmA	MIAMI SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
MtB1	MILTON SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

				Hydric Soil Component				
Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
HtB2	MILTON SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
Nn	NINEVEH LOAM	None						
OcA	OCKLEY SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
OcB1	OCKLEY SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
OcB2	OCKLEY SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
OcC2	OCKLEY SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
OkB3	OCKLEY SOILS, 2 TO 6 PERCENT SLOPES, SEVERELY ERODED	None						
OkC3	OCKLEY SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
RgD2	RODMAN GRAVELLY LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
RgE1	RODMAN GRAVELLY LOAM, 18 TO 25 PERCENT SLOPES, SLIGHTLY ERODED	None						
RgE2	RODMAN GRAVELLY LOAM, 18 TO 25 PERCENT SLOPES, MODERATELY ERODED	None						
RgF2	RODMAN GRAVELLY LOAM, 25 TO 50	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table H

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	PERCENT SLOPES, ERODED							
Ro	ROSS SILT LOAM	None						
RsA	RUSSELL SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
RsB1	RUSSELL SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
RsB2	RUSSELL SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
RsC1	RUSSELL SILT LOAM, 6 TO 12 PERCENT SLOPES, SLIGHTLY ERODED	None						
RsC2	RUSSELL SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
RsD1	RUSSELL SILT LOAM, 12 TO 18 PERCENT SLOPES, SLIGHTLY ERODED	None						
RsD2	RUSSELL SILT LOAM, 12 TO 18 PERCENT SLOPES, MODERATELY ERODED	None						
RsE1	RUSSELL SILT LOAM, 18 TO 25 PERCENT SLOPES, SLIGHTLY ERODED	None						
RsE2	RUSSELL SILT LOAM, 18 TO 25 PERCENT SLOPES, MODERATELY ERODED	None						
RtB3	RUSSELL SOILS, 2 TO 6 PERCENT	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

				Hydric Soil Component				
Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	SLOPES, SEVERELY ERODED							
RtC3	RUSSELL SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
RtD3	RUSSELL SOILS, 12 TO 18 PERCENT SLOPES, SEVERELY ERODED	None						
RtE3	RUSSELL SOILS, 18 TO 25 PERCENT SLOPES, SEVERELY ERODED	None						
RuA	RUSSELL AND MIAMI SILT LOAMS, 0 TO 2 PERCENT SLOPES	None						
RuB1	RUSSELL AND MIAMI SILT LOAMS, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
RuB2	RUSSELL AND MIAMI SILT LOAMS, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
RuC1	RUSSELL AND MIAMI SILT LOAMS, 6 TO 12 PERCENT SLOPES, SLIGHTLY ERODED	None						
RuC2	RUSSELL AND MIAMI SILT LOAMS, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
RvB3	RUSSELL AND MIAMI SOILS, 2 TO 6 PERCENT SLOPES, SEVERELY ERODED	None						
RvC3	RUSSELL AND MIAMI SOILS, 6 TO 12 PERCENT SLOPES,	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	SEVERELY ERODED							
Rw	RIVERWASH	None						
WnB1	WYNN SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
WnB2	WYNN SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
WnC2	WYNN SILT LOAM, 6 TO 12 PERCENT SLOPES, MODERATELY ERODED	None						
WnD2	WYNN SILT LOAM, 12 TO 25 PERCENT SLOPES, MODERATELY ERODED	None						
WyC3	WYNN SOILS, 6 TO 12 PERCENT SLOPES, SEVERELY ERODED	None						
XeA	XENIA SILT LOAM, 0 TO 2 PERCENT SLOPES	None						
XeB1	XENIA SILT LOAM, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
XeB2	XENIA SILT LOAM, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED	None						
XnA	XENIA AND CELINA SILT LOAMS, 0 TO 2 PERCENT SLOPES	None						
XnB1	XENIA AND CELINA SILT LOAMS, 2 TO 6 PERCENT SLOPES, SLIGHTLY ERODED	None						
XnB2	XENIA AND CELINA	None						

THE FOLLOWING MAP UNITS ARE HYDRIC SOILS OR MAY HAVE INCLUSIONS OF HYDRIC SOILS
Table M

Soil Survey Area - UNION COUNTY, INDIANA

AREAS MAPPED AS WATER OR DENOTED BY ONE OF THE FOLLOWING CONVENTIONAL SYMBOLS ARE CONSIDERED A HYDRIC SOIL MAP UNIT; MARSH OR SWAMP; WET SPOT; STREAMS; LAKES, PONDS, AND RESERVOIRS.

Map Unit Symbol	Map Unit Name	Hydric Soil Component Name	Location of Hydric Soil Component	Hydric Soil Component: Meets Saturation Criteria	Meets ponding criteria	Meets flooding criteria	Natural vegetation is woody	Can be farmed under natural conditions
	SILT LOAMS, 2 TO 6 PERCENT SLOPES, MODERATELY ERODED							

APPENDIX C

FWS and DNP Correspondence

SAGAMORE ENVIRONMENTAL SERVICES, INC.

June 14, 2001

Mr. Scott Pruitt
United States Department of the Interior
Fish and Wildlife Service
Bloomington Field Office
620 South Walker Street
Bloomington, Indiana 47403-2121

RE: SPECIES AND HABITAT DATA REQUEST
SILVER CREEK AND HANNA'S CREEK WATERSHED DIAGNOSTIC STUDY
UNION COUNTY, INDIANA
SAGAMORE ENVIRONMENTAL SERVICES PROJECT NUMBER 00-0681M

Dear Mr. Pruitt:

Sagamore Environmental Services, Inc. is requesting information regarding endangered, threatened and rare species, high quality natural communities, and significant natural areas for the above-mentioned location in Indiana. The following describes the location of the study area:

County	*Quadrangles*
Union	College Corner, OH-IN; Fairhaven, OH-IN; Liberty, IN; New Fairfield, IN

The purpose of the watershed diagnostic study is to assess the current condition of the Silver Creek and Hanna's Creek watersheds and to make recommendations for potential restoration and mitigation projects. The study area consists of approximately 27,000 acres of predominantly agricultural property within Union County, Indiana. A map delineating the boundaries of the watersheds is included.

Species and habitat information will be used for comparative purposes within the diagnostic study report and as consideration characteristics for potential restoration and/or mitigation project sites. Information used will credit the United States Department of the Interior, Fish and Wildlife Service as the source of the material.

Sincerely,

Jason C. Hignite
Natural Resources Specialist
Sagamore Environmental Services, Inc.

8502 Castleway Drive • Suite 100 • Indianapolis, IN 46250 • (317) 842-0510 • Fax (317) 842-0547

United States Department of the Interior

FISH AND WILDLIFE SERVICE

BLOOMINGTON FIELD OFFICE (ES)
620 South Walker Street
Bloomington, Indiana 47403-2121
(812) 334-4261 FAX 334-4273

IN REPLY REFER TO

June 29, 2001

RECD JUL 02 2001

Jason Hignite, Natural Resources Specialist
Sagamore Environmental Services, Inc.
8002 Castleway Drive
Suite 104
Indianapolis, Indiana 46250

Dear Mr. Hignite:

This responds to your letter dated June 14, 2001, requesting U.S. Fish and Wildlife Service (FWS) database review for endangered, threatened, and rare species and/or critical habitats in the Silver Creek and Hanna's Creek watersheds in Union County, Indiana.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and the U. S. Fish and Wildlife Service's Mitigation Policy.

The aforementioned area is within the range of the federally endangered Indiana bat (*Myotis sodalis*) and federally threatened bald eagle (*Haliaeetus leucocephalus*). We have no records of either species occurring within the Silver Creek or Hanna's Creek watersheds, however there is suitable summer habitat for the Indiana bat in both watersheds.

This is provided for informational purposes only and does not preclude the need for further consultation as required under Section 7 of the Endangered Species Act of 1973, as amended.

If you have any questions, please call Barbara Hosler at (812) 334-4261 ext. 209.

Sincerely yours,

Michael A. Litwin
for
Scott E. Pruitt
Field Supervisor

SAGAMORE
ENVIRONMENTAL SERVICES, INC.

June 14, 2001

Mr. Ron Hellmich
Division of Nature Preserves
Indiana Department of Natural Resources
402 West Washington Street, Room W267
Indianapolis, Indiana 46204

**RE: ENDANGERED, THREATNENED, AND RARE SPECIES DATA REQUEST
SILVER CREEK AND HANNA'S CREEK WATERSHED DIAGNOSTIC STUDY
UNION COUNTY, INDIANA
SAGAMORE ENVIRONMENTAL SERVICES PROJECT NUMBER 00-0681M**

Dear Mr. Hellmich:

Sagamore Environmental Services, Inc. is requesting information regarding endangered, threatened and rare species, high quality natural communities, and significant natural areas for the above-mentioned location in Indiana. The following describes the location of the study area:

County	*Quadrangles*
Union	College Corner, OH-IN; Fairhaven, OH-IN; Liberty, IN; New Fairfield, IN

The purpose of the watershed diagnostic study is to assess the current condition of the Silver Creek and Hanna's Creek watersheds and to make recommendations for potential restoration and mitigation projects. The study area consists of approximately 27,000 acres of predominantly agricultural property within Union County, Indiana. A map delineating the boundaries of the watersheds is included.

Species and habitat information will be used for comparative purposes within the diagnostic study report and as consideration characteristics for potential restoration and/or mitigation project sites. Information used will credit the Division of Nature Preserves as the source of the material.

Sincerely,

Jason C. Hignite
Natural Resources Specialist
Sagamore Environmental Services, Inc.

DNR Indiana Department of Natural Resources

Frank O'Bannon, Governor
Larry D. Macklin, Director

Division of Nature Preserves
402 W. Washington Street, Rm W267
Indianapolis, IN 46204-2739

REC'D JUN 25 2001

June 22, 2001

Mr. Jason C. Hignite
Sagamore Environmental Services, Inc.
8002 Castleway Drive, Suite 104
Indianapolis, IN 46250

Dear Mr. Hignite:

I am responding to your request for information on the endangered, threatened, or rare (ETR) species, high quality natural communities, and natural areas documented from the Silver Creek and Hanna Creek watersheds, Union County, Indiana. The Indiana Natural Heritage Data Center has been checked and enclosed you will find information on the ETR species and significant areas documented from these watersheds.

For more information on the animal species mentioned, please contact Katie Smith, Nongame Supervisor, Division of Fish and Wildlife, 402 W. Washington Room W273, Indianapolis, Indiana 46204, (317)232-4080.

The information I am providing does not preclude the requirement for further consultation with the U.S. Fish and Wildlife Service as required under Section 7 of the Endangered Species Act of 1973. You should contact the Service at their Bloomington, Indiana office.

U.S. Fish and Wildlife Service
620 South Walker St.
Bloomington, Indiana 47403-2121
(812)334-4261

At some point, you may need to contact the Department of Natural Resources' Environmental Review Coordinator so that other divisions within the department have the opportunity to review your proposal. For more information, please contact:

Larry Macklin, Director
Department of Natural Resources
attn: Stephen H. Jose
Environmental Coordinator
Division of Fish and Wildlife
402 W. Washington Street, Room W273
Indianapolis, IN 46204
(317)232-4080

Please note that the Indiana Natural Heritage Data Center relies on the observations of many individuals for our data. In most cases, the information is not the result of comprehensive field surveys conducted at particular sites. Therefore, our statement that there are no documented significant natural features at a site should not be interpreted to mean that the site does not support special plants or animals.

Due to the dynamic nature and sensitivity of the data, this information should not be used for any project other than that for which it was originally intended. It may be necessary for you to request updated material from us in order to base your planning decisions on the most current information.

Thank you for contacting the Indiana Natural Heritage Data Center. You may reach me at (317)232-4052 if you have any questions or need additional information.

Sincerely,

Ronald P. Hellmich

Ronald P. Hellmich
Indiana Natural Heritage Data Center

enclosure: data sheet

June 22, 2001

ENDANGERED, THREATENED AND RARE SPECIES,
HIGH QUALITY NATURAL COMMUNITIES, AND SIGNIFICANT NATURAL AREAS DOCUMENTED
FROM SILVER AND HANNA WATERSHEDS, UNION COUNTY, INDIANA

TYPE	SPECIES NAME	COMMON NAME	FED	STATE	LOCATION	DATE	COMMENTS
FAIRHAVEN							
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T12NR01W 28	1998	
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T12NR01W 34	1998	
LIBERTY							
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T11NR01W 08	1998	
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T11NR01W 09	1998	
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T11NR01W 04	1998	
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T12NR01W 33	1998	
NEW FAIRFIELD							
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T11NR01W 19	1998	
Fish	CLINOSTOMUS ELONGATUS	REDSIDE DACE	**	SE	T11NR01W 17	1998	

STATE: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant, ** no status but rarity warrants concern

FEDERAL: LE=endangered, LT=threatened, LE,LT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, E/SA=appearance similar to LE species, **=not listed

APPENDIX D

Demographic Data Sources

Status of Indiana Families
. . . Today and Tomorrow

Union County 1996 Profile

At a glance. . .	*Number*	*Rank in State*	*Percent of State**
Population (1994 estimate)	7,279	91	0.13
Population Density (population per sq. mile)	43.2	82	—
Labor Force (1994 estimate)	3,930	91	0.13
Unemployment Rate (1994 estimate)	5.6	35	114.29
Per Capita Income (1993 estimate)	$14,548	86	75.72
Households (1995 projection)	2,600	91	0.12
Family Households (1995 projection)	1,990	91	0.13
Families in Poverty (1990 census)	135	91	0.11

*Percent of state for unemployment rate and per capita income are based on Indiana = 100. If this number is higher than 100, then the county's rate or per capita is higher than the state average.

Migration Patterns

People five years of age and older who moved between 1985 and 1990

Moved into Union County:			
From other Indiana counties			
712			
From other states			
737			
IL	KY	MI	OH
47	22	2	440

Moved out of Union County:			
To other Indiana counties			
736			
To other states			
365			
IL	KY	MI	OH
0	79	15	67

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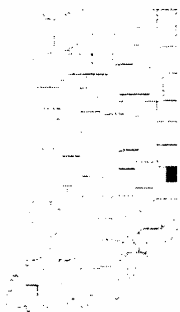
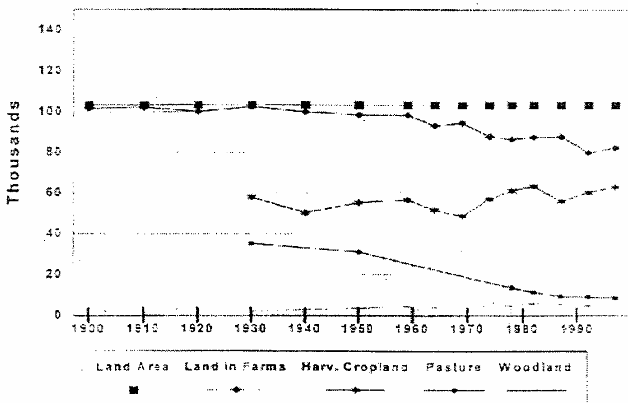
Indiana University School of Business
Indiana Business Research Center

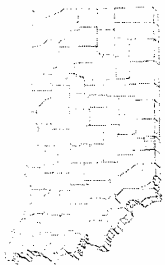
INDIANA FARM LAND USE HISTORY
Union County, Indiana



Total Land Area 1997 - 103,398 Acres

Year	Land In Farms	Harvested Cropland	Land Pastured	Woodland Not Pastured
	Acres			
1900	101,710	n/a	n/a	n/a
1910	102,182	n/a	n/a	n/a
1920	100,269	n/a	n/a	n/a
1930	102,571	57,910	35,113	2,848
1940	100,192	50,252	n/a	n/a
1950	98,646	55,311	31,237	3,667
1959	98,514	56,658	n/a	4,771
1964	93,400	51,621	n/a	4,340
1969	94,673	48,667	n/a	n/a
1974	87,992	57,148	n/a	n/a
1978	86,718	61,293	13,791	5,210
1982	87,721	63,491	11,606	5,150
1987	87,958	55,104	9,597	5,557
1992	80,069	60,422	9,265	4,987
1997	82,400	63,111	8,718	5,393





Living Poor in Indiana...

Status of Indiana Families Today and Tomorrow
1998 Profile

Union County

A Demographic Overview

Population

Total Population *1997*	7,272
Under age 5 *1997*	472
School age (5-24) *1997*	2,049
Working Age (25-64) *1997*	3,723
Older (65 plus) *1997*	1,028

Resident Labor Force

Total Labor Force *1997*	3,930
Employed *1997*	3,795
Unemployed *1997*	135
Unemployment rate *1997*	3.4

Families on Welfare

Total number of families on welfare *1997*	37
Number of welfare recipients *1997*	89
Payments (year total) *1997*	$95,049
Average monthly payment per family *1997*	$214
Percent of population receiving welfare *1997*	0.8
Average number of food stamp recipients *1997*	349

Income & Earnings

Median household income *1993*	$30,105
Per capita personal income *1996*	$18,455
Average earnings per job *1996*	$16,482
Per manufacturing job *1996*	$41,511
Per services job *1996*	$12,674
Per retail job *1996*	$14,938

Living in Poverty

Number of persons *1993*	801
Percent of total population *1993*	10.9
Number of children under 18 *1993*	294
Percent of all persons in poverty *1993*	36.7

Housing & Households

Owner occupied units *1990*	1,863
Renter occupied units *1990*	713
Median home value *1990*	$41,800
Total households *2000*	2,700
Family households *2000*	2,070

Purdue University
School of Consumer & Family Sciences
Center for Families

Indiana University
Kelley School of Business
Indiana Business Research Center

1997 Census of Agriculture County Profile

United States Department of Agriculture
Indiana Agricultural Statistics Service

UNION
INDIANA

Land in farms

Increased 3 percent from 80,069 acres in 1992 to 82,500 acres in 1997.

Average size of farms

Increased 3 percent from 299 acres in 1992 to 308 acres in 1997.

Full time farms

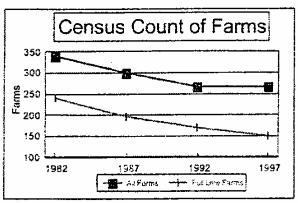
Decreased 12 percent from 170 farms in 1992 to 150 farms in 1997.

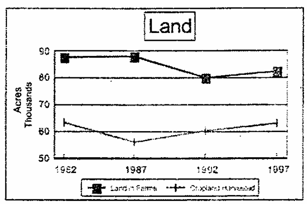
Market value of agricultural products sold

Increased 9 percent to $25,709,000 in 1997.
Crop sales accounted for 69 percent of the market value.
Livestock sales accounted for 31 percent of the market value.

Market value of agricultural products sold, average per farm

Increased 9 percent from $87,725 in 1992 to $95,929 in 1997.





APPENDIX E

Archaeological Records Review

ARCHAEOLOGICAL RECORDS REVIEW

for

SILVER CREEK AND HANNA'S CREEK WATERSHED DIAGNOSTIC STUDY UNION COUNTY, INDIANA

By

Anthony W. Adderley, M.S.
Project Archaeologist

SAGAMORE
ENVIRONMENTAL
SERVICES, INC.

Table of Contents

Figures

Table

Appendix

Introduction

In conjunction with the Silver Creek and Hanna's Creek watershed diagnostic study, Sagamore Environmental Services, Inc. (Sagamore) has completed an archaeological records review of the watersheds area. The proposed project covers portions of fifty-six sections within T12N R2W, T12N R1W T11N R2W and T11N R1W, on the USGS 7.5' Liberty, New Fairfield, Fairhaven and College Corner Indiana and Ohio Quadrangles (Figure 1). Approximately 27,000 acres will be assessed for this project.

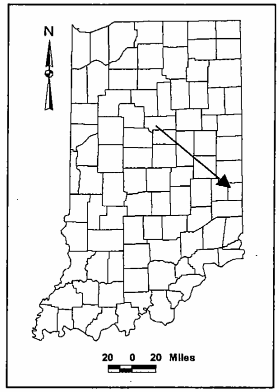


Figure 1. Approximate location of the project area, within Union County, Indiana.

Records Review

The records check utilized site records, maps and materials on file at Sagamore, the Ball State University Archaeological Resources Management Service and the Indiana Department of Natural Resources (IDNR), Division of Historic Preservation and Archaeology (DHPA) to locate, identify and evaluate the known and expected cultural resources within the project area. The records search was conducted at a level specific to the project area and its vicinity.

•Setting

Physiography

The project area is located in the bedrock physiographic unit known as the Dearborn Upland (Schneider 1966:54), within the Tipton Till Plain and Switzerland Hills Sections (Homoya 1985). This area is underlain by Ordivician shale and limestone (Burger 1971, Gutschick 1966:3, 5). Surface deposits in the area are within the Center Grove Till Member of the Trafalgar Formation (USGS 1994:65, Wayne 1966:26) and within the general physiographic unit known as the Dearborn Upland (Schneider 1966:41). The project area is within the Whitewater River watershed (Kingsbury 1972:18, USGS 1994:18) and is located in a morainal environmental zone.

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The presettlement vegetation of the area predominately consisted of a beech - maple forest (Petty and Jackson 1966:280). Deposits of Laurel chert, a significant prehistoric resource, are available in primary outcrops in the local area (Cantin 1996).

Soils

Numerous soil associations are located within the study area. Within the floodplains of both Hanna Creek and Silver Creek is the nearly level Genesee-Eel association. Included in this association are the Genesee and Eel series which, because they are well drained and alluvial, have a moderate to high potential to contain buried cultural resources. The Russell-Miami and Russell-Hennepin associations are found along most of the more dissected blufflines and dissected uplands. Both of these associations consist predominantly of well drained, sloping to steep silty soils which developed over till. In upland areas of little relief, the Xenia-Celina association predominates. This association is described as moderately well drained, gently sloping or nearly level soils which developed over till (Alfred, S.D., et. al. 1960).

•Background

Cultural History

The region encompassing and surrounding Union County, Indiana, has archaeological evidence spanning the entire range of Midwestern North American prehistory (Kellar 1983, Swartz 1981). This evidence is from professional investigations and private collections that have discovered remains from Paleoindian (ca. 12,000 - 9,500 BP) up to Woodland (ca. 2,700 - 350 BP) archaeological time periods.

Archaeological sites do not occur evenly across the landscape, but instead are patterned in relation to specific landscape elements and resource locations. These settlement patterns are distinct for various cultural-temporal manifestations and reflect the adaptive strategies (subsistence systems) practiced by prehistoric peoples. As such, the settlement pattern of a particular hunter-gatherer group would be quite distinct from that of a more sedentary agriculturalist population, although the settlement patterns between various hunter-gatherer (or agriculturalist) groups also vary through time and across space.

Because groups of prehistoric peoples developed a variety of adaptive systems over time in response to changing environmental conditions and the introduction of new technologies, the distribution of sites and site types (e.g., villages, specialized hunting or nut processing camps, chert working stations,

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etc.) are expected to reflect these changes. In a *generalized* model of prehistoric settlement and subsistence, relatively large and sedentary base camps and villages would be predicted to occur on floodplain features and blufflines in close proximity to major drainages. These site types are typically large (relative to other site types of a given culture) and contain midden and pit feature deposits. In addition, the artifact assemblages are composed of large numbers of functionally diverse items, reflecting the wide range of social, political, religious, and domestic activities which took place. Because resources required by the inhabitants of such sites did not always occur in close proximity or were available only within discrete seasons, it would be necessary, at times, for groups to establish smaller, more highly specialized ancillary camps. Task-oriented groups would occupy these camps for relatively short periods of time in order to acquire and process nuts, butcher game, and manufacture chert tools. Consequently, the specialized or limited activity camps often lack significant deposits such as midden and pit features, and their artifact assemblages are usually limited to small numbers of functionally restricted types. Ancillary camps can occur in a wide variety of settings, but many have been identified in upland settings near streams. However, because of their short term and specialized nature, ancillary or similar camps have a potential to provide invaluable information and in some instances are considered significant and of National Register quality.

Diagnostic artifacts recovered from surface and excavation contexts in Union and surrounding counties indicate 12,000 years of human occupation (Kellar 1983). The earliest known human occupations in the area were by the Paleoindian manifestations dating to some 10,000-12,000 years B.P. The Paleoindian occupations of the surrounding area are known only from isolated artifacts in disturbed/plowzone contexts with the absence of any other associated artifacts or deposits (Tankersley 1987). Little is known of the Paleoindian period in Indiana, although evidence from sites located throughout North America indicate populations consisted of small groups of highly mobile hunters who occupied the region during the waning of the Pleistocene and the beginning of the Holocene. Data from Indiana suggests the greatest frequency of sites are located in riparian settings closest to lithic raw material outcrops (Tankersley et. al. 1990). To date no *in situ* Paleoindian deposits have been identified in Indiana.

Early Archaic sites from the area are similar to those of the preceding Paleoindian period. They are similar in that they are usually small in size, contain small quantities of lithic debris and lack associated midden or pit features. Tools represented at Early Archaic sites are a variety of notched points and unifacial scrapers. In Indiana, sites with *in situ* deposits dating to the Early Archaic period are somewhat rare and frequently deeply buried in flood plain settings (Cantin 1986; Smith 1986; Stafford and Cantin 1992). Local Early Archaic projectile point types include Thebes, Kirk and Bifurcate base cluster points (Justice 1987).

The Middle Archaic period is better represented in Indiana in general than those of earlier manifestations. Sites dating to this period are usually larger and have a more functionally diverse association of tools. Included in this toolkit are points from the Godar and Matanzas cluster (Justice 1987), as well as hafted scrapers, bifaces, hardstone/groundstone tools such as axes, mortars, pestles and atlatl weights, as well as a broad range of bone tools and large quantities of fire cracked rock. Available data suggest that during the latter portions of this period (5500-5000 BP) some sites were being occupied for longer periods of time on a seasonal and perhaps multi-seasonal basis (Stafford 1994). These base camps often have dark midden stains, numerous associated pit features, and in some instances human and dog burials (Anslinger 1988).

Late Archaic cultures in Indiana are poorly known and understood. Riverton (Winters 1969; Anslinger 1987) peoples occupied the central and southern portions of Indiana during the latter portions of the Late Archaic (ca 3500-2700 BP). Larger, more permanent base camps are located along major drainages, although smaller, more specialized sites used for the procurement and processing of subsistence resources are also reported. Riverton sites are usually identified by the presence of small, expediently manufactured points and tools of local gravel cherts.

The earliest evidence of Woodland occupation of the area occurred some 2700 years ago. Regionally, sites dating to this period are distinguished from earlier Archaic occupations by the presence of ceramic technology as well as a greater influence on mortuary ceremonialism and social complexity. Adena culture sites are the most commonly identified Early Woodland occupations of the east-central Indiana. Adena sites usually consist of small villages/hamlets with large residential structures which are located near major drainages. Burial ceremonialism continues to heighten during Adena times, including log or bark lined tombs constructed inside man-made earthen mounds. Glidewell Mound (Homsher 1884, Kolbe 1992), located to the south in Franklin County, provides a clear example. Evidence suggests a hunting and collecting subsistence strategy, although Limited experimentation with agriculture is suggested with the cultivation of squash (*Cucurbita pepo*) and starchy seeds, mainly Goosefoot (*Chenopodium berlandieri*), Maygrass (*Phalaris caroliniana*) and Knotweed (*Polygonum erectum*), all of which occupy a prominent position in many Middle and Late Woodland seed collections (Asch and Asch 1985). Ceramics are described as thick with very coarse grit temper. Vessels are typically jar shaped with flattened bases and cordmarked interior and exterior surfaces. Points commonly associated with this period include the Adena and Saratoga clusters (Justice 1987). The use of Wyandotte and other higher quality chert types replaces the use of local gravel cherts.

The Middle Woodland Period is dominated by the Hopewell Culture. This culture is largely a continuation of the preceding Adena period. However, Hopewell Cultures saw the climax of burial ceremonialism, widespread trade and social interaction (Kellar 1983). There is also some early evidence of maize cultivation during this time period.

The Late Woodland saw a decline in the construction of earthworks and mounds, and a major reduction in trade and the use of exotic materials. Late Woodland cultures are very poorly defined in Indiana, especially in the Whitewater drainage. Components of the Albee Phase, while geographically confined to the White River drainage and its tributaries, are linked to the region. Diagnostic artifacts include globular, grit tempered jars with wedge shaped profiles. Exterior surfaces are vertically cordmarked. Points recovered from Late Woodland contexts include the Madison trianguloid varieties (Justice 1987). Temporal limits have not been established, although current data suggests a range from 1200-800 years B.P. (Anslinger 1990).

Mississippian occupations in this portion of Indiana are also poorly understood. While trianguloid points and some shell tempered ceramics have been identified, evidence of any major occupations is lacking. Fort Ancient, a culture that developed from Woodland traditions and was contemporaneous with Mississippian cultures, took aspects of each culture. Subsistence patterns, house types and stockaded villages had origins in Mississippian influence, while Fort Ancient ceramics are mainly a continuation of Late Woodland traditions.

The land that makes up Union County was obtained from the Miami Indians in four separate treaties, the Treaty of Greenville in 1794, the Treaty at Vincennes in 1805, the 'Twelve Mile Purchase' in 1809 and the 1818 Treaty of St. Mary's (Guernsey 1932).

The area began to experience Euro-American settlement by people from the Carolinas, Pennsylvania and New Jersey as early as 1804. The first town was named Union and sat along Hanna's Creek. By 1810, there were schools and churches in every township (www.unioncountyin.com).

Union County was officially established in 1821 from portions of Wayne, Franklin and Fayette Counties. Brownsville was designated as the County Seat, but the town of Liberty, established in 1822, eventually became the permanent county seat due to its central location within the county (Taylor et al. 1989). Like the surrounding counties, Union County has a strong agricultural economic base, which was made stronger by the emergence of the railroad system connecting the area to more distant markets.

Significant historical activities documented in the vicinity of the project area center around the Town of Liberty, and include the Cincinnati Hamilton and Indianapolis Railroad. Historical maps of the county (Anonymous 1876, Guernsey 1932) show the portion of the county that will be affected by this project was very rural. The southwestern portion of the county, mainly those sections that are near the Whitewater River, appears to be more heavily populated in 1876. While roadways crisscross the county, few churches and schoolhouses are evident on the 1876 Atlas.

Archaeology

Information on file at the DHPA shows that at least 330 archaeological sites have been documented in Union County (DHPA 2001). According to DHPA and BSU files, 40 sites are recorded within the project area. Site-specific details are given in Table 1. Available information taken from site forms is very limited for some of the sites located within the study area. A selected site synopsis of those sites which did not have limited data are available in Appendix A.

Records show that two small portions of the area under consideration have been covered by an archaeological reconnaissance (Schmitt and Zoll 1996, Moore 1989). Moore's 1989 survey was conducted on an approximate eight acre area which was to be developed for a day use horseman's area within the Whitewater State Park. This survey located five sites (12Un184-12Un188), three prehistoric and two historic/prehistoric. Each of these sites is described as low density scatters of material, none of which are considered eligible for inclusion to the NRHP. Schmitt and Zoll's survey was conducted for extensions of the Brookville Lake Regional Waste District. It covered approximately 7.5 miles of right of way along SR101, encompassing some 20 acres. This survey, while spatially larger than Moore's only documented two sites (12Un305 and 306). Site 12Un305 is a low density lithic scatter of indeterminate cultural/temporal affiliation. Site 12Un305 is a low density historic scatter dating to the late 19^{th} / early 20^{th} centuries. Neither of these sites is considered eligible for inclusion to the NRHP.

Site #	Quadrangle	Site Type	Affiliation	Significance	Recommendations
12U7	New Fairfield	Lithic Scatter	Early Archaic	Not Available	Further testing
12U35	Liberty	Mounds	Woodland	Not Available	Further testing
12U36	Liberty	Mound	Woodland	Not Available	Further testing
12U40	Liberty	Mound	Woodland?	Not Available	Further testing
12U41	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U42	Liberty	Lithic Scatter	Woodland	Not Available	Further testing
12U43	Liberty	Lithic Scatter	Early Archaic	Not Available	Further testing
12U44	Liberty	Mound	Woodland?	Not Available	Further testing
12U45	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U46	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U47	Fairhaven	Isolate	Unidentified	Not Available	Further testing
12U48	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U49	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U50	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U53	Fairhaven	Lithic Scatter	Early Archaic	Not Available	Further testing
12U54	Liberty	Campsite	Unidentified	Not Available	Further testing
12U56	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U57	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U58	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U59	Liberty	???	Unidentified	Not Available	Further testing
12U66	CollegeCorner	???	Unidentified	Not Available	Further testing
12U98	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U101	Liberty	Mound	Woodland	Not Available	Further testing
12U110	Liberty	Mound	Woodland	Not Available	Further testing
12U132	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U133	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U137	Liberty	Lithic Scatter	Unidentified	Not Available	Further testing
12U139	Fairhaven	Lithic Scatter	Unidentified	Not Available	Further testing
12U141	New Fairfield	Isolate	Unidentified	Not Eligible	Further testing
12U162	New Fairfield	Mound	Woodland	Not Available	Further testing
12U184	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U185	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U186	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U187	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U188	New Fairfield	Lith/Hist Scatter	Unidentified	Not Eligible	No further testing
12U298	New Fairfield	Lithic Scatter	Unidentified	Not Available	Resurvey
12U306	New Fairfield	Lithic Scatter	Unidentified	Not Eligible	No further testing
12U325	Liberty	Farmstead	Historic/Euro	Not Eligible	No further testing
12U329	New Fairfield	Lithic Scatter	Late Archaic	Not Eligible	No further testing
12U330	New Fairfield	Hist Scatter	Historic/Euro	Not Eligible	No further testing

Table 1. Sites located within the Silver Creek and Hanna's Creek Watershed Project

Discussion

Numerous archaeological surveys have been conducted within and surrounding the proposed project (Homsher 1882, Setzler 1930, Koleszar 1972, Kolbe 1992, Angst 1994). Early surveys of the region were mainly focused on identifying more prominent and impressive archaeological sites, predominantly mound groups and larger habitation sites. Homsher (1882) identified a total of 86 archaeological sites to the south in the area that encompasses the present day Brookville Reservoir. Setzlers (1930) survey mainly focused on resurveying and reevaluating those sites which were originally identified by Homsher, however, this survey also identified some 22 additional sites. During Setzlers survey, it became apparent that the area's archaeological resources, mainly earthworks, were being destroyed at an alarming rate. By 1929, 58% of the sites recorded on reservoir property had been destroyed.

More recently, Koleszar (1972) conducted an archaeological survey of Union County, recording many of the sites within the current project. A total of 107 archaeological sites were recorded during this survey, 22 of which are located within the current project area. Kolbe (1992) surveyed a total of 590 acres within Union and neighboring Franklin County surrounding the Brookville Lake, and identified sites or material dating to all major prehistoric time periods. During this survey, Kolbe reports a site density of one site per 4.2 acres in the Brookville Lake area. Angst (1994) systematically surveyed approximately 747 acres in neighboring Fayette County documenting some 275 sites, also dating to all major prehistoric time periods. While Kolbe reported site densities for the area of Brookville Lake, Angst reports site densities for individual environmental zones within the Dearborn Upland physiographic region. Angst reports a site density of one site per 2.51 acres for the Morainal environmental zone.

Of the 40 sites currently documented within the proposed project area, the most commonly identified are those of Woodland (mainly earthworks) and Early Archaic traditions. However, given that the majority of the area under consideration for this project has not been systematically examined for archaeological resources by professional archaeologists, those sites reported undoubtedly represent but a small percentage of those that actually exist. Based on the project's location near a primary chert source and the diversity of habitats and associated biomass in the area, the region is capable of supporting intensive prehistoric occupation. Furthermore, alluvial sediments located adjacent to Silver and Hanna's Creeks have the potential to contain archaeological resources deeply buried beneath the surface.

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Conclusions & Recommendations

Pursuant to Section 106 of the National Historic Preservation Act of 1966, further survey or testing may be required in selected areas prior to ground disturbing activities. In consideration of the above discussion, the following recommendations are made:

> Avoidance of all known archaeological sites within the project area that have been deemed eligible for inclusion to the National Register of Historic Places is recommended. Of the 40 sites located within the project area, only eleven have been deemed "not eligible", leaving 29 sites whose eligibility is uncertain. If ground disturbing activities are to be conducted on these sites, further archaeological survey/testing is recommended.
>
> Considering previous surveys within the area, as well as site density information and the carrying capacity of the local region, further survey is considered necessary if ground disturbing activities are to take place within the project area. Any archaeological survey undertaken in conjunction with this project should be conducted at a level specific to the areas to be impacted.

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APPENDIX A

SELECTED SITE SYNOPSIS

Site #: 12Un7
Location: Sec. 25, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain-Upland Flat
Nearest Water: Hanna's Creek
Materials Recovered: 3 unmodified flakes
7 modified flakes
10 FCR noted
Cultural Affiliation: Unknown
Site Type: Lithic scatter
Assessment: The site was originally reported by Setzler (1930), and was resurveyed by Koleszar (1970). Personnel from Ball State University revisited the site in 1992, however, no systematic survey of the area was conducted at the time. No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un35
Location: Sec. 1, T10N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Ridge Spur
Nearest Water: Dubouis Creek
Materials Recovered: No material collected
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Setzler (1930), and was resurveyed by Koleszar (1970). Personnel from Ball State University revisited the site in 1996, however, no systematic survey of the area was conducted at the time. No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un36
Location: Sec. 28, T11N R2W, Liberty Twp., Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain
Nearest Water: Unnamed intermittent stream
Materials Recovered: No material collected
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Homsher (1884), and was resurveyed by Setzler (1930), and again by Koleszar (1970). Personnel from Ball State University revisited the site in 1992, however, no systematic survey of the area was conducted at the time. Although the mound is reported to be heavily disturbed, Kolbe (1992) states the site appears to have intact deposits.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un40
Location: Sec. 1, T11N R2W, Union Co., IN
Quadrangle: Liberty
Physiography: North slope of hill.
Nearest Water: Unnamed intermittent stream
Materials Recovered: No materials collected
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un42
Location: Sec. 16, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Lowland
Nearest Water: N/A
Materials Recovered: Grooved axes, pestles, chert, FCR, celt
Cultural Affiliation: Woodland
Site Type: Lithic Scatter/Habitaion
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un49
Location: Sec. 9, T12N R1W, Union Co., IN
Quadrangle: Liberty
Physiography: N/A
Nearest Water: Richland Creek
Materials Recovered: Blanks, knives, spall, points, scraper
Cultural Affiliation: Archaic
Site Type: Lithic Scatter
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un50
Location: Sec. 16, T12N R1W, Union Co., IN
Quadrangle: Liberty
Physiography: N/A
Nearest Water: N/A
Materials Recovered: Chert chips, bannerstone

Cultural Affiliation: Indeterminate
Site Type: Lithic Scatter
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un53
Location: Sec. 11, T12N R1W, Union Co., IN
Quadrangle: Fairhaven
Physiography: Slight rise in open field
Nearest Water: Silver Run
Materials Recovered: Chert chips, FCR, point, core
Cultural Affiliation: Archaic
Site Type: Lithic scatter/Habitation
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un56
Location: Sec. 12, T12N R2W, Union Co., IN
Quadrangle: Liberty
Physiography: Small hill
Nearest Water: N/A
Materials Recovered: Chert chips and slabs, FCR, knife
Cultural Affiliation: Woodland
Site Type: Workshop
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un57
Location: Sec. 11, T12N R1W, Union Co., IN
Quadrangle: Fairhaven
Physiography: Glacial esker
Nearest Water: Silver Creek
Materials Recovered: Grooved ax, FCR, points
Cultural Affiliation: Indeterminate
Site Type: Lithic scatter/Habiation
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.

Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un58
Location: Sec. 28, T12N R1W, Union Co., IN
Quadrangle: Liberty
Physiography: First terrace
Nearest Water: Hanna's Creek
Materials Recovered: Chert chips, FCR, points, knife, preform
Cultural Affiliation: Indeterminate
Site Type: Lithic Scatter/Habitation
Assessment: The site was originally reported by Koleszar (1970). No previous survey of the site has resulted in recommendations concerning significance, and the available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un101
Location: Sec. 25, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain
Nearest Water: Hanna's Creek
Materials Recovered: 4 unmodified flakes
1 modified flake
1 core
2 FCR noted
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Homsher (1884), and was resurveyed by Setzler (1930) and Koleszar (1970). Personnel from Ball State University revisited the site in 1992, however, no systematic survey of the area was conducted at the time. The available data is not sufficient to determine significance at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un110
Location: Sec. 34, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain
Nearest Water: N/A
Materials Recovered: Stone grave, copper bracelets, banded slate gorgets—all reported
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Setzler (1930), and was resurveyed by Koleszar (1970). Personnel from Ball State University revisited the site in 1996, however, the mound was not relocated at the time. The available data is not sufficient to determine significance at this time.
Recommendations: Additional assessment is recommended if this site is to be impacted by ground disturbing activities.

Site #: 12Un139
Location: Sec. 18, T11N R1W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Valley edge
Nearest Water: Hanna's Creek
Materials Recovered: 1 core
5 flakes
1 utilized flake
1 retouched flake
1-25 FCRr noted
Cultural Affiliation: Indeterminate
Site Type: Lithic scatter/Habitation
Assessment: Personnel from Ball State University reported the site in 1994, however, no recommendations were made concerning significance. The available data is not sufficient to offer such a determination at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un162
Location: Sec. 33, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain
Nearest Water: N/A
Materials Recovered: No material collected
Cultural Affiliation: Woodland
Site Type: Mound
Assessment: The site was originally reported by Homsher (1884), and was resurveyed by Koleszar (1970). Personnel from Ball State University revisited the site in 1996, however, the mound could not be located at that time. While Koleszar (1970) states the mound is destroyed, subsurface deposits may still be intact. The available data is not sufficient to offer a determination concerning significance at this time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

Site #: 12Un298
Location: Sec. 25, T11N R2W, Union Co., IN
Quadrangle: New Fairfield
Physiography: Till Plain
Nearest Water: Unnamed intermittent stream
Materials Recovered: 8 unmodified flakes
8 modified flakes
1 biface fragment
1 core
12 FCR noted
Cultural Affiliation: Indeterminate
Site Type: Lithic scatter/Habitation
Assessment: Personnel from Ball State University visited the site in 1992, however, no systematic survey of the area was conducted at the time.
Recommendations: If the site is to be impacted by ground disturbing activities, additional assessment is recommended to determine if the site is eligible for inclusion to the National Register of Historic Places.

APPENDIX F

Hanna's Creek Government Records Review

EcoSearch Environmental Resources, Inc.
8606 Allisonville Road, Suite 300
Indianapolis, Indiana 46250
ph: (317) 577-9797 fax: (317) 577-9191

EcoSearch

Government Records Search

Type of Report:	Priority Risk Report
Site Location:	**Hannas Creek Watershed** **Liberty, IN 47353**
Date:	March 23, 2001
Report ID Number:	2276-7102
Especially Prepared For:	Mr. Kent Shadley Sagamore Environmental Service
Project #:	00-0681M

Limits of Information:
Customer proceeds at its own risk in choosing to rely on EcoSearch Environmental Resources, Inc. ("EcoSearch") services, in whole or in part, prior to proceeding with any transaction. EcoSearch cannot be an insurer of the accuracy of the information, errors occurring in the conversion of data, or for customer's use of the data. EcoSearch and its affiliated companies, officers, agents, employees, and independent contractors cannot be held liable for accuracy, storage, delivery, loss, or expense suffered by the customer resulting directly or indirectly from any information provided by EcoSearch Environmental Resources, Inc.

Thank you for choosing EcoSearch.

Introduction

We want to thank you for your order requesting the enclosed site assessment.

EcoSearch makes every effort possible to combine the most accurate environmental data available into an understandable and easy-to-use format.

While every attempt has been made to ensure accuracy of the information presented, we cannot guarantee the accuracy of the data from the original sources, nor can we guarantee that no transcription or plotting errors have occurred.

If any concerns arise from your review of the databases in this report, please call the appropriate agency involved. As a service, we have included phone numbers in the database description section of this report to help you in your evaluation.

The enclosed maps present a working approximation of the location of surrounding environmental sites based primarily on available accurate site addresses. These maps should not be used for purposes more correctly handled by surveys.

EcoSearch is driven by its mission to present the most responsive, technically sound, and cost-effective environmental data services available to our customer.

Read Me First

The following suggestions are offered in an attempt to help you in using and understanding this site assessment from EcoSearch:

1. Skim over the entire report to familiarize yourself with its contents and layout.

2. You will notice that the information is presented following this general concept: we begin by giving sections that summarize data and then give detailed information about these summaries as you proceed further into the report.

3. Then refer to the section titled "Statistical Overview". You will need to take a moment to read the column headings and the data below them. Also, as you go down the first column (left side) you will probably need to look back at the preceeding section titled "Database Descriptions". Please pay particular attention to the radius searched as they vary according to the database. These are ASTM standards that we meet and exceed. Your site's datum is the third, shaded column. Also, the next column showing database hits within the first radius is important as it will include data about adjoining properties. The unmappable sites have their own section with a cover page explaining them.

4. The next section titled "Maps" is important as it gives a very clear visual presentation of the site, and which database(s) are at the site itself or within the study radii.

5. The site summary page(s) tells you by map ID# which database is at that location as well as the site's name and distance/direction from your study site. You will notice that the numbering corresponds to the distance from the subject site-- eg. #1 is your site itself or the site closest to it, #2 is further away. This continues until all database hits have been summarized within the largest study radius. Your report may extend further than one mile if you asked us to extend the radii.

6. As you will recall our format goes from summary-type pages to detailed information. Therefore, the next section is "Detailed Data". Here extensive data is given about each database hit. The map ID#, distance, and direction are in the top left corner. Further data follows.

7. The "Unmappable" section was referred to earlier. In this summary you will find those sites. Please read the cover page as it describes unmappable sites and our efforts to minimize and/or eliminate them from all of our site assessments.

8. The last two divisions -- "Radon" and "Glossary/Acronyms" are self-explanatory and often helpful to our customers.

If you would like further help in understanding our reports please call as our intention is to have this report helpful to you.

Database Descriptions -- Federal Databases

NPL

National Priorities List

US Environmental Protection Agency		Data Date:	December 29, 2000
Office of Solid Waste and Emergency Response		Release Date:	December 29, 2000
(703) 603-8881		Active Date:	January 26, 2001
		Last Contact Date:	January 26, 2001

The NPL is a subset of the CERCLIS and lists over 1,150 of the nation's most dangerous sites of uncontrolled or hazardous waste which require cleanup. Also known as the Superfund List, the sites are scored according to the hazardous ranking system.

CERCLA (Active)

Comprehensive Environmental Response, Compensation, and Liability Information System (Active)

US Environmental Protection Agency		Data Date:	December 29, 2000
Office of Solid Waste and Emergency Response		Release Date:	December 29, 2000
1-800-775-5037		Active Date:	January 26, 2001
		Last Contact Date:	January 26, 2001

CERCLIS maintains information on over 15,000 sites nationally identified as hazardous or potentially hazardous which may require action. These sites are currently being investigated or an investigation has been completed regarding the release of hazardous substances. The most serious of this list as ranked by the hazardous ranking system are transferred to the NPL.

CERCLA (NFRAP Archive)

Comprehensive Environmental Response, Compensation, and Liability Information System (NFRAP Archive)

US Environmental Protection Agency		Data Date:	December 29, 2000
Office of Solid Waste and Emergency Response		Release Date:	December 29, 2000
1-800-775-5037		Active Date:	January 26, 2001
		Last Contact Date:	January 26, 2001

For more complete information purposes we include sites which have been reclassified as No Further Remedial Action Planned (NFRAP) by the EPA. This action was taken by the EPA beginning February 1995 as a part of the Brownfields Redevelopment Program. These former CERCLIS sites, also known as the CERCLIS Archive, have been delisted because a lack of significant contamination was found.

RCRA TSD

Resource Conservation and Recovery Information System -- Treatment, Storage, and Disposal Facilities

US Environmental Protection Agency		Data Date:	April 15, 2000
Office of Solid Waste and Emergency Response		Release Date:	April 15, 2000
(202) 260-4610		Active Date:	August 7, 2000
		Last Contact Date:	January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The TSD database is a subset of the complete RCRIS file which includes facilities which treat, store, dispose, or incinerate hazardous waste. Additionally, compliance and corrective action (CORRACTS) information is included.

RCRA LQ Generator

Resource Conservation and Recovery Information System -- Large Quantity Generator

US Environmental Protection Agency		Data Date:	April 15, 2000
Office of Solid Waste and Emergency Response		Release Date:	April 15, 2000
(202) 260-4610		Active Date:	August 7, 2000
		Last Contact Date:	January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The generators database is a subset of the complete RCRIS file which includes hazardous waste generators which create more than 1000kg of hazardous waste per month or meet other requirements of RCRA.

RCRA SQ Generator

Resource Conservation and Recovery Information System -- Small Quantity Generator

US Environmental Protection Agency		Data Date:	April 15, 2000
Office of Solid Waste and Emergency Response		Release Date:	April 15, 2000
(202) 260-4610		Active Date:	August 7, 2000
		Last Contact Date:	January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The generators database is a subset of the complete RCRIS file which includes hazardous waste generators which create more than 100kg and less than 1000kg of hazardous waste per month or meet other requirements of RCRA.

CORRACTS

Resource Conservation and Recovery Information System -- Corrective Action Sites

US Environmental Protection Agency		Data Date:	April 15, 2000
Office of Solid Waste and Emergency Response		Release Date:	April 15, 2000
(202) 260-4610		Active Date:	August 7, 2000
		Last Contact Date:	January 18, 2001

The CORRACTS database includes RCRIS (Resource Conservation and Recovery Information System) sites with reported corrective action. This information is also reported in the standard RCRIS detailed data.

ERNS

Emergency Response Notification System

US Environmental Protection Agency		Data Date:	January 1, 2000
Office of Solid Waste and Emergency Response		Release Date:	January 1, 2000
(202) 260-2342		Active Date:	March 17, 2000
		Last Contact Date:	January 18, 2001

ERNS is a national database which contains information on specific notification of releases of oil and hazardous substances into the environment. The system stores data regarding the site of the spill, the material released, and the medium into which it occured.

PCS

Permit Compliance System (NPDES Data)

US Environmental Protection Agency

Data Date:	October 15, 1997
Active Date:	October 15, 1997

The Permit Compliance System Database contains information on permitted discharge information from the National Pollutant Discharge Elimination System.

Database Descriptions -- State Databases

SCL (HWS)

Indiana State Cleanup List

Indiana Department of Environmental Management		Data Date:	December 8, 1998
Office of Environmental Response		Release Date:	December 8, 1998
(317) 308-3008		Active Date:	June 15, 1999
		Last Contact Date:	March 7, 2001

This database identified sites deemed by the State of Indiana for remediation. It also includes sites designated for immediate removal, voluntary cleanup, and hazardous ranked sites listed on the IDEM Commissioner's Bulletin No. 6 (dated 12/10/95).

SWF

Indiana Permitted Solid Waste Facilities

Indiana Department of Environmental Management		Data Date:	February 16, 2000
Office of Solid Waste Management		Release Date:	February 16, 2000
(317) 232-3399		Active Date:	February 29, 2000
		Last Contact Date:	February 22, 2001

This state database lists sites which are regulated for solid waste disposal by the State of Indiana. It is updated twice a year by the Office of Solid Waste Management.

LUST

Indiana Leaking Underground Storage Tank List

Indiana Department of Environmental Management		Data Date:	January 8, 2001
		Release Date:	January 8, 2001
(317) 308-3008		Active Date:	January 13, 2001
		Last Contact Date:	March 7, 2001

The IDEM LUST list contains information on underground storage tanks with reported releases into the environment. Agency Required Disclaimer: This information is an unconfirmed, non-verified list of reported notifications or releases at facilities or sites. It should not be used for or considered as a final Agency determination of whether proper notification, actual releases, or the completion of remedial activities have occurred. In providing this list, the Agency makes no representation regarding the accuracy of the information.

UST

Indiana Registered Underground Storage Tank List

Indiana Department of Environmental Management		Data Date:	January 8, 2001
Underground Storage Tank Branch		Release Date:	January 8, 2001
(317) 308-3008		Active Date:	January 13, 2001
		Last Contact Date:	March 6, 2001

The Indiana UST list provides the location of registered underground storage tanks. Agency Required Disclaimer: This information is an unconfirmed, non-verified list of reported notifications or releases at facilities or sites. It should not be used for or considered as a final Agency determination of whether proper notification, actual releases, or the completion of remedial activities have occurred. In providing this list, the Agency makes no representation regarding the accuracy of the information.

SPILL

Indiana Spills Database

Indiana Department of Environmental Management		Data Date:	January 13, 2000
		Release Date:	January 13, 2000
(317) 308-3023		Active Date:	March 8, 2000
		Last Contact Date:	March 1, 2001

The Indiana Spills Database contains information about reported hazardous materials spills and fish kills in the State of Indiana.

USPILL

Indiana Union County Spills Data

Union County Emergency Management		Data Date:	January 2001
765-458-9504		Active Date:	March 7, 2001
		Last Contact Date:	March 7, 2001

The Indiana Union County Spills Database contains information about reported hazardous material spills in the county of Union.

CFO

Indiana Confined Feeding Operations

Indiana Department of Environmental Management		Data Date:	January 2001
Office of Land Quality			
317-232-3529		Active Date:	March 8, 2001
		Last Contact Date:	March 7, 2001

Confined feeding is the raising of animals for food, fur or recreation in lots, pens, ponds, sheds or buildings, where they are confined, fed and maintained for at least 45 days during any year, and where there is no ground cover or vegetation present over at least half of the animals' confinement area. Livestock markets and sale barns are generally excluded. Indiana law defines a confined feeding operation as any livestock operation engaged in the confined feeding of at least 300 cattle, or 600 swine or sheep, or 30,000 fowl, such as chickens, ducks and other poultry. The Indiana Department of Environmental Management (IDEM) regulates these confined feeding operations, as well as smaller livestock operations which have violated water pollution rules or laws, under IC 13-18-10, the Confined Feeding Control Law.

EcoSearch Statistical Overview

Property Information

Hannas Creek Watershed
Liberty, IN 47353

Latitude: 39.631369 N Longitude: 84.87602 W

Search Parameters

Report: Priority Risk Report
Radii: ASTM*
Zip Code(s): 47353
City: Liberty Harrison Center Union Harmony
County: Union

FEDERAL DATABASES	Radius (miles)	Mappable Sites: Total	Site	Area Vicinity**	within 0.00mi	0.00 - 0.00mi	0.00 - 0.00mi	Unmappable Sites: Zip Code	City	County
NPL	Site	0	0	0	-	-	-	0	0	0
CERCLA (Active)	Site	0	0	0	-	-	-	0	0	0
CERCLA (NFRAP Archive)	Site	0	0	0	-	-	-	0	0	0
RCRA TSD	Site	0	0	0	-	-	-	0	0	0
RCRA LQ Generator	Site	0	0	0	-	-	-	0	0	0
RCRA SQ Generator	Site	1	0	1	-	-	-	0	0	0
CORRACTS	Site	0	0	0	-	-	-	0	0	0
ERNS	Site	1	0	1	-	-	-	-	-	-
PCS	Site	0	0	0	-	-	-	0	0	0

STATE DATABASES	Radius (miles)	Mappable Sites: Total	Site	Area Vicinity**	within 0.00mi	0.00 - 0.00mi	0.00 - 0.00mi	Unmappable Sites: Zip Code	City	County
SCL (HWS)	Site	0	0	0	-	-	-	0	0	0
SWF	Site	0	0	0	-	-	-	0	0	0
LUST	Site	0	0	0	-	-	-	1	0	0
UST	Site	2	0	2	-	-	-	1	-	-
SPILL	Site	1	0	1	-	-	-	0	-	-
USPILL	Site	1	0	1	-	-	-	0	0	0
CFO	Site	4	0	4	-	-	-	0	0	0

MANUAL GEOCODING:˜ For this city/township, 59 sites were manually plotted by EcoSearch.

* This database search and study radii meets or exceeds the ASTM (American Society of Testing and Materials) standards for a government records review.

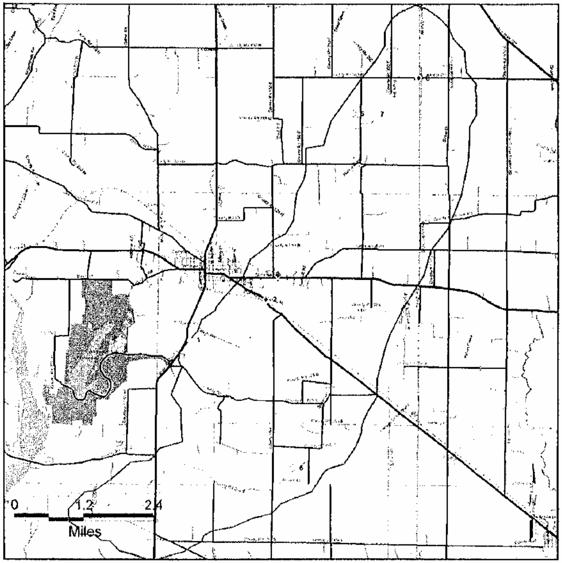
** Area Vicinity indicates that Environmental Area Records were found near your study site. These records detail contamination or other environmental conditions in a wide area which cannot be placed to a single point or more precisely plotted. More research is necessary to determine the possible environmental impact of these Area Records to your study site.

˜ Manual Geocoding: Plotting environmental site data using paper maps and phone calls to properly place the information on the map.

Accurate street addresses are required for records to be found at the study property.

Mappable Sites are environmental sites which were located and appear on the enclosed EcoSearch Map, Site Summary, and Detailed Data sections of the report. These sites are summarized based on proximity to the study site.

Unmappable Sites are governmental records with incomplete or inaccurate address information. These sites could not be located on the street map, but have been searched by the Zip Codes, Cities, and County specified in the search parameters. Further investigation of these sites and their relationship to your study site is necessary.



EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7102
Site: Hannes Creek Watershed
Liberty, IN 47353

Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

MULTIPLE MATCHES / AREAS

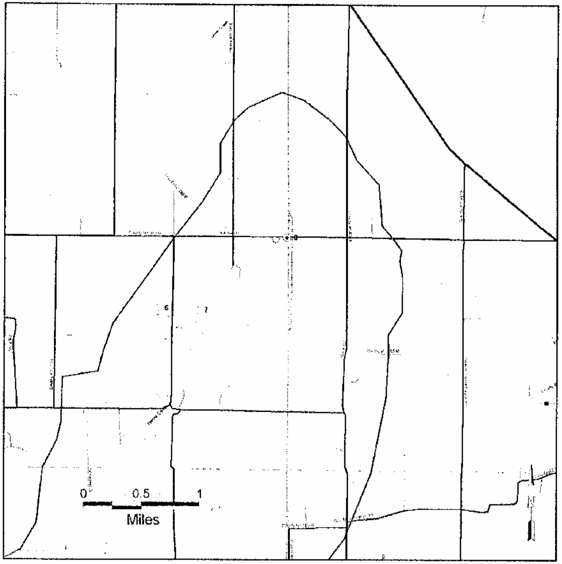
Two Database Matches
Three or More Matches
Database Area Site

MAP LEGEND

Parks	Streets
Incorp. Areas	Secondary Roads
Water	Primary Roads
Cemeteries	Freeways
	Railroads
	Boundaries

Radii:

Note: The information contained on this map is subject to the general disclaimer on the first page.



Note: The information contained on this map is subject to the general disclaimer on the first page.

EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7102
Site: Hannas Creek Watershed
Liberty, IN 47353

Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

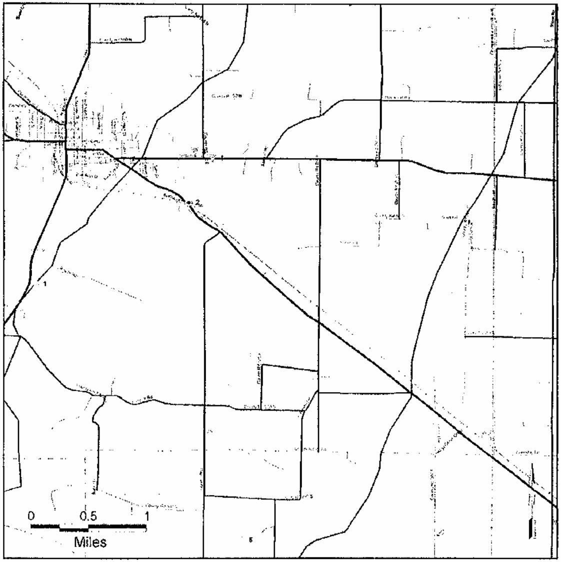
MULTIPLE MATCHES / AREAS

- Two Database Matches
- Three or More Matches
- Database Area Site

MAP LEGEND

	Streets
Parks	Secondary Roads
Incorp. Areas	Primary Roads
Water	Freeways
Cemeteries	Railroads
	Boundaries

Radii:



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Liberty, IN 47353

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Two Database Matches
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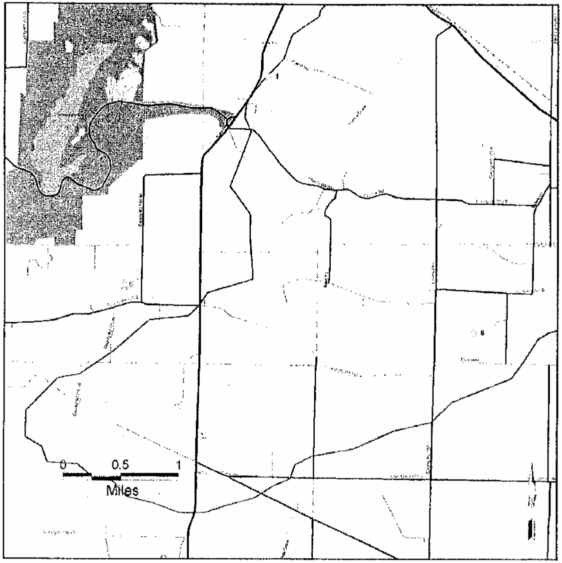

EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7102
Site: Hannas Creek Watershed
Liberty, IN 47353

Study Area

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CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

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Two Database Matches
Three or More Matches
Database Area Site

MAP LEGEND

Parks
Incorp. Areas
Water
Cemeteries
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Radii:

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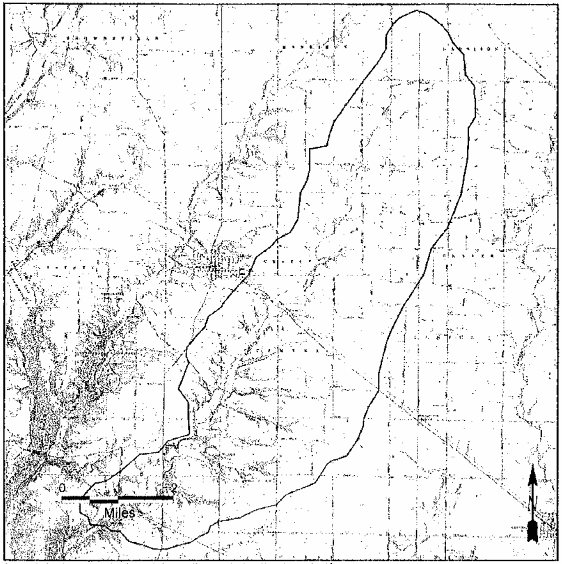


Source: United States Geological Survey, 7.5 minute Topographic Map (Digital Raster Graphics)

EcoSearch Environmental Resources, Inc.

USGS 7.5 Minute Topographical Map

Report ID: 2276-7102
Site: Hannas Creek Watershed
Liberty, IN 47353

○ Target Area

Map Features are Color Coded

Black -- Cultural features such as roads and buildings.

Blue -- Hydrographic features such as lakes and rivers.

Brown -- Hypsographic (elevation) features shown by contour lines.

Green -- Woodland cover, scrub, orchards, and vineyards.

Red -- Important roads and public land survey system.

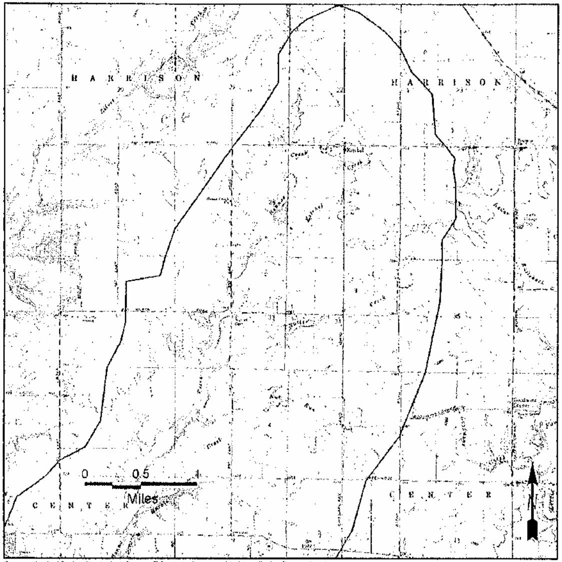
Purple -- Features added from aerial photographs during map revision. The changes are not field checked.

A detailed Topographic Map Symbols pamphlet is available from EcoSearch free upon request.

Radii: 0.25 mile, 0.50 mile, 1.00 mile

Topographical Maps:

Liberty, IN -- 1974
Fairhaven, OH IN -- 1960
New Fairfield, IN -- 1974
Photorevised 1981/1994
College Corner, OH IN -- 1992



Source: United States Geological Survey, 7.5 minute Topographic Map (Digital Raster Graphics)

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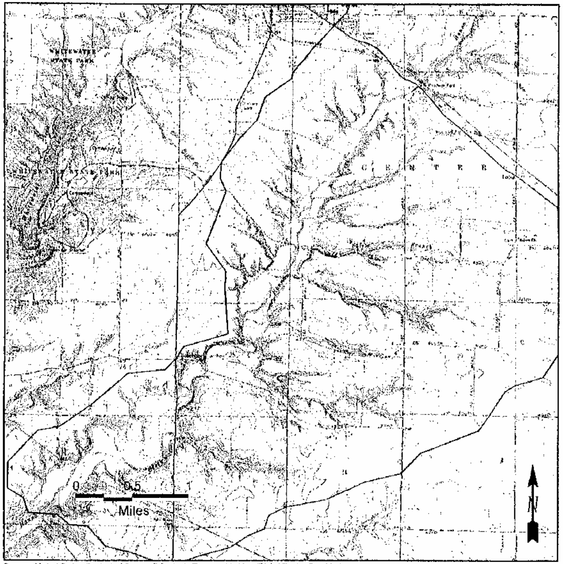

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Photorevised 1981/1994
College Corner, OH IN -- 1992

Site Summary

Map ID#	Database / Agency ID#	Site Name, Address, and County	Distance/Direction
1	CFO Indiana Confined Feeding Operations 1514	DONALD J SENOUR 100 S SR 101 LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
2A	UST Indiana Underground Storage Tank 15077	UNION COUNTY CO OP COTTAGE GROVE 2469 S US HIGHWAY 27 LIBERTY, IN 47353-9797 UNION	0.00000 mi - Manually Geocoded*
2B	ERNS Emergency Response Notification System 594661	UNION COUNTY FARM COOP 2469 SOUTH HWY 27 LIBERTY, IN UNION	0.00000 mi - Manually Geocoded*
3	USPILL Indiana Union County Spills Data UNSPIL2	1112 E.KITCHEL RD. 1112 E.KITCHEL RD. LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
4	SPILL Indiana Spills Database Site 8906070	KAISER ESTECH 1/2 MI EAST OF LIBERTY LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
5	CFO Indiana Confined Feeding Operations 4576	N J J FARMS, INC. APPROX SALEM & LIBERTY PIKE LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
6	CFO Indiana Confined Feeding Operations 4728	STEVENS FARMS INC LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
7	CFO Indiana Confined Feeding Operations 1513	HANNAH'S CREEK PIG FARM .75 MI W & .5 MI S OF KITCHELL LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
8A	RCRA Generator RCRA Small Quantity Generator IND980590350	KAISER AGRICULTURAL CHEMICALS RR 3 LIBERTY, IN 47353-9803 UNION	0.00000 mi - Manually Geocoded*
8B	UST Indiana Underground Storage Tank 9175	KAISER AG CHEMICALS INC RR 3 BOX 186 LIBERTY, IN 47353-9437 UNION	0.00000 mi - Manually Geocoded*

* -- Manually Geocoded: Site plotted or corrected using paper maps, phone calls, and other resources to properly place the site on the map.

** -- Agency Provided Lat/Long: Site plotted using the latitude and longitude given by the federal or state government agency.

*** -- Area Manually Plotted: Area manually drawn using digital and paper maps.

Detailed Data

The following pages contain the detailed data concerning the sites plotted on the map and included in the site summary.

Please Note: Pages are not included for databases not found within the search radii.

These pages are arranged as follows:

RCRA TSD and Generators Data

ERNS Data

Indiana UST Data

Indiana SPILLS Data

Union Spills Data

Confined Feeding

RCRA TSD and Generators Data

Facility and Compliance Information

Map ID#: **8A**
Distance (mi): 0.000000
Direction: -
EPA ID#: IND980590350
Status: Small Quantity Generator
Land Type: Unknown
Record Date: 08/18/1980
Used Oil Recyc Unverified

Name: KAISER AGRICULTURAL CHEMICALS
Address: RTE 3
City, State, Zip: LIBERTY IN 47353
SIC Code:
Contact Name: ROY AMBROSE
Contact Phone: 317-458-5161

RCRA Evaluation / Violation / Enforcement Data

No Compliance Information Reported

RAATS (RCRA Administrative Action Tracking System) Data

No RAATS Information Reported for this Site

RCRA Corrective Action Data (CORRACTS) Instrument and Event Data

No Corrective Action Instrument Information for this Site

RCRA Wastes and Waste Code Information previously reported by EcoSearch have been removed from the RCRIS database by the USEPA.

ERNS Data

Emergency Response Notification System Data

Map ID#: 2B   Distance (mi): 0.000000
Direction: -

ID #: 594661   Location: 2469 SOUTH HWY 27
City, State, Zip: LIBERTY, IN

Time Released: 9/15/98 17:30 Deaths: 0 Injuries: 0 Evacuations: 0 Property Damage: 0.00

Medium Affected: Air
Name of Affected Medium: ATMOSPHERE

Cause of Release: Not Reported
Additional Cause: Not Reported

Source: Not Reported
Transportation Mode: Fixed Facility

Discharger information (if reported):
UNION COUNTY FARM COOP
2469 SOUTH HWY 27
LIBERTY IN

Release Description: NURSE TANK / A VALVE FAILED CAUSING A RELEASE OF AMMONIA TO THE ATMOSPHERE

Action Description: RELEASE WAS SECURED

Misc. Information: WILL NOTIFY:SERC

Material(s) Spilled:	Quantity	Units	Quan in Water	Units in Water	Pounds
AMMONIA, ANHYDROUS	230.00	GAL		NON	1,907.00

Indiana UST Data

Indiana Registered Underground Storage Tank Data

Map ID#:	2A	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	15077			Name:	UNION COUNTY CO OP COTTAGE GROVE
				Address:	2469 S. US HWY 27
Owner:	Union County Farm Bureau Co-Op			City, State Zip:	LIBERTY, IN 47353
Address:	Po Box 70				
City, State Zip:	Liberty, IN 47353				
Phone:	317-458-5141				

Tank Id:	Capacity	Status	Installed	Closed
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported

Map ID#:	8B	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	9175			Name:	KAISER AG CHEMICALS INC
				Address:	RR 3 BOX 186
Owner:	Kaiser Agriculture Chemicals Inc			City, State Zip:	LIBERTY, IN 47353
Address:	Rr 3 Box 186				
City, State Zip:	Liberty, IN 47353				
Phone:	317-458-5161				

Tank Id:	Capacity	Status	Installed	Closed
1	1,000.00	Permanently Out of Service	Not Reported	Not Reported
2	10,000.00	Permanently Out of Service	Not Reported	Not Reported
3	1,000.00	Permanently Out of Service	Not Reported	Not Reported

Indiana SPILL Data

Indiana Spills Data

Map ID#: **4**

Agency ID:	8906070	Distance (mi):	0.00000	Responsible Party:	KAISER ESTECH
		Direction:	-	Reported Address:	1/2 MI EAST OF LIBERTY
				City, Zip:	Liberty 47353
Incident Date:	6/11/89	Incident Type:	Spill	Circumstances:	Transportation Accident
Reported Date:	6/11/89	Area Affected:	200 Ft 2		

Reported By:	Responsible Party (RP)	Fish Killed:	0.00
Investigated By:	ERS - Field Response	Water Supply Affected:	No
Spill Source:	Agricultural	Waterway Affected:	None
Enforcement Actio	None	Environmental Consequences:	Minimal - Log Only
Action Taken:	Cleaned Up		

Spill Material:	Treflan	Amount Recovered:	5 Gallons
Spill Amount:	5 Gallons	Cleanup Duration:	1 Day
		Contained:	Yes

Indiana Union County SPILL Data

Indiana Union County Spills Data

Map ID#:	3	Distance (mi):	0.00000		
		Direction:	-	Reported Address:	1112 E.Kitchel Rd.
Agency ID:	Not Reported			City, Zip.	Liberty IN,47353
Reported Date:	10/06/99				
				Medium Affected:	Not Reported
				Name of Affected Medium:	Loading area
Injuries:	0			Spill Source:	tanker truck
				Cause of Release:	operator error
Deaths:	0			Release Description:	used machine coolant released from relief valve on tanker during loading
Evacuations:	0			Material(s) Spilled:	used coolant
Property Damage	0			Quantity Spilled	15 gal.
				Quantity in Water:	0

Action Taken: contained and cleaned up

Indiana Confined Feeding Operation Data

Indiana Confined Feeding Operations List

Map ID#: 1
Distance (mi): 0.00000
Direction: -

Operation Name: Not Reported
Operation Location: 100 S SR 101
City, State, Zip: LIBERTY IN, 47353
Section,Township,Range: 13 11N 14E
Contact Name: DONALD J SENOUR
Contact Address: 973 S SR 101

Log #: 1514
AW#: 470
Status: VOIDED

Solid Man. System
Concrete Pits: X
Earthen Pits:

Water Quality Violations: N
Existing Bldgs.
Proposed Bldgs: 1

Decision Date: 07/01/74

Swine:	170	Veal:	0		
Dairy:	0	Chicken:	0	Duck	0
Beef:	0	Turkey	0	Sheep:	0

Map ID#: 5
Distance (mi): 0.00000
Direction: -

Operation Name: N J J FARMS, INC.
Operation Location: APPROX SALEM & LIBERTY PIKE
City, State, Zip: LIBERTY IN, 47353
Section,Township,Range: 29 11N 1W
Contact Name: JAY BRATTAIN
Contact Address: 3285 S SALEM RD

Log #: 4576
AW#: 4803
Status: ACTIVE

Solid Man. System: X
Concrete Pits: X
Earthen Pits: X

Water Quality Violations: N
Existing Bldgs.: 6
Proposed Bldgs

Decision Date: 06/28/99

Swine:	1530	Veal:			
Dairy:	0	Chicken:	0	Duck	
Beef:	0	Turkey		Sheep:	

Map ID#: 6
Distance (mi): 0.00000
Direction: -

Operation Name: STEVENS FARMS INC
Operation Location: Not Reported
City, State, Zip: LIBERTY IN, 47353
Section,Township,Range: 28 12N 1W
Contact Name: DALE S STEVENS
Contact Address: 2424 E KITCHEL RD

Log #: 4728
AW#: 4061
Status: ACTIVE

Solid Man. System: X
Concrete Pits: X
Earthen Pits:

Water Quality Violations: N
Existing Bldgs.: 6
Proposed Bldgs

Decision Date: 03/1/496

Swine:	1353	Veal:	0		
Dairy:	0	Chicken:	0	Duck	0
Beef:	0	Turkey	0	Sheep:	0

Map ID#: 7
Distance (mi): 0.00000
Direction: -

Operation Name: HANNAH'S CREEK PIG FARM
Operation Location: .75 MI W & .5 MI S OF KITCHELL
City, State, Zip: LIBERTY IN, 47353
Section,Township,Range: 28 12N 1W
Contact Name: JOE FLOYD
Contact Address: Not Reported

Log #: 1513
AW#: 713
Status: VOIDED

Solid Man. System
Concrete Pits: X

Water Quality Violations: N

Indiana Confined Feeding Operation Data

Earthen Pits:		Existing Bldgs.	5		
		Proposed Bldgs	1		
Decision Date:	06/30/75				
Swine:	1224	Veal:	0		
Dairy:	0	Chicken:	0	Duck	0
Beef:	0	Turkey	0	Sheep:	0

Unmappable Sites

A limitation of many records of governmental databases is incomplete or incorrect address information. Without proper addresses, it is more difficult to locate and map these sites.

Instead of leaving these potentially important sites out of the EcoSearch report, we implement a painstaking manual geocoding strategy aimed at plotting these unmappable sites by looking at zip codes, city names, and county names identified with the radius around your study site. The zip codes, cities, and counties searched are identified on the EcoSearch Statistical Overview page.

Our sophisticated mapping software, enhanced TIGER street maps, and address correction database processing methods find and plot most environmental sites. We then perform manual geocoding, plotting those sites the computer fails to find using a variety of resources. These include using our in-house collection of paper maps, directories, cross-referencing database information, and calling post offices, local government, or the sites themselves to accurately locate environmental records. We also correct obvious TIGER street map errors and omissions.

This effort at manual geocoding results in a short or non-existant orphan/unmappable list and increases accuracy and reliability of the data in our reports. We have elected not to computerize this part of our report due to the importance of presenting all data as completely and accurately as humanly possible. When this function is computerized it is impossible to produce a report as accurate as one where manual geocoding has taken place.

The limited number of sites which could not be reasonably found through our geocoding strategy are presented in this section for further review to assess their impact on your study site.

After the summary unmappable site information, detailed data follows.

Unmappable Sites

Database	Agency ID#	Site Name and Address	County
UST Indiana Underground Storage Tank	18246	SEE FAC ID 10339 RR 2 LIBERTY, IN 47353-9802	UNION
LUST Indiana Leaking Underground Storage Tank	199303514	SEE FAC ID 10339 RR 2 LIBERTY, IN 47353-9802	UNION

Indiana LUST Data

Indiana Leaking Underground Storage Tank Data

Map ID#:	2UN	Distance (mi):	0.00000		
		Direction:			
Agency ID:	199303514			Name:	SEE FAC ID 10339
				Address:	RR 2
Priority:	Low			City, State Zip:	LIBERTY, IN 47353
Substance:	Not Reported				
				Status:	No Further Action

Media Affected:
Soil

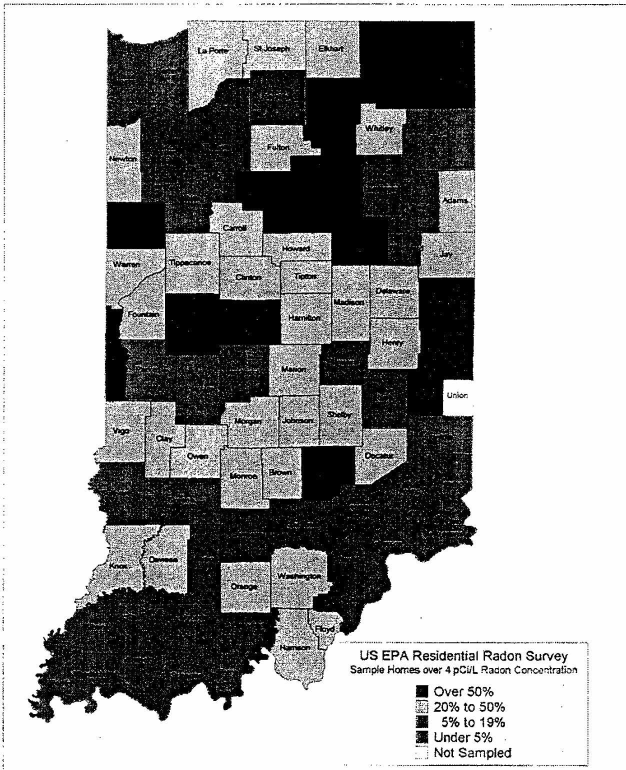
Indiana UST Data

Indiana Registered Underground Storage Tank Data

Map ID#:	1UN	Distance (mi):	0.00000		
		Direction:			
Agency ID:	18246			Name:	SEE FAC ID 10339
				Address:	RR 2
Owner:	Disputed Ownership			City, State Zip:	LIBERTY, IN 47353
Address:	Owner Uncertain				
City, State Zip:	Indianapolis, IN 46207				
Phone:	Not Reported				

Tank Id:	Capacity	Status	Installed	Closed
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported

EcoSearch Radon Risk Map for Indiana



SOURCE: EPA Map for Radon Zones (Indiana), September 1993. The data is based on the The data is based on the State/EPA Residential Radon Survey which was conducted in Indiana during the winters of 1987-88. This map shows the percentage of homes in each county registering over 4 pCi/L (picocuries per liter) radon concentration. For additional information on this survey, consult the next page.

Note: The information provided on this map is subject to the disclaimer on the first page. This map is NOT intended to determine if a property in a given county should be tested for radon.

Properties with elevated levels of radon have been found in all counties.

If or when radon is a concern, all properties should be tested regardless of the county designation.

EPA Residential Radon Survey for Indiana

County	Sample Size	Homes over 4pCi/L Number	Homes over 4pCi/L Percentage	Homes over 20pCi/L Number	Homes over 20pCi/L Percentage
Adams	14	5	35.71%	0	0.00%
Allen	169	29	17.16%	2	1.18%
Bartholomew	28	16	57.14%	0	0.00%
Benton	2	1	50.00%	0	0.00%
Blackford	4	0	0.00%	0	0.00%
Boone	9	5	55.56%	0	0.00%
Brown	3	1	33.33%	0	0.00%
Carroll	7	2	28.57%	0	0.00%
Cass	6	3	50.00%	0	0.00%
Clark	92	17	18.48%	1	1.09%
Clay	8	2	25.00%	0	0.00%
Clinton	7	2	28.57%	0	0.00%
Crawford	2	0	0.00%	0	0.00%
Daviess	5	1	20.00%	0	0.00%
De Kalb	21	12	57.14%	0	0.00%
Dearborn	6	1	16.67%	0	0.00%
Decatur	5	1	20.00%	0	0.00%
Delaware	16	4	25.00%	0	0.00%
Dubois	5	0	0.00%	0	0.00%
Elkhart	76	31	40.79%	0	0.00%
Fayette	6	3	50.00%	0	0.00%
Floyd	32	8	25.00%	0	0.00%
Fountain	13	6	46.15%	3	23.08%
Franklin	4	0	0.00%	0	0.00%
Fulton	9	2	22.22%	0	0.00%
Gibson	16	2	12.50%	0	0.00%
Grant	13	7	53.85%	1	7.69%
Greene	16	0	0.00%	0	0.00%
Hamilton	23	6	26.09%	0	0.00%
Hancock	8	1	12.50%	0	0.00%
Harrison	19	8	42.11%	2	10.53%
Hendricks	22	3	13.64%	0	0.00%
Henry	11	3	27.27%	0	0.00%
Howard	22	7	31.82%	0	0.00%
Huntington	13	1	7.69%	0	0.00%
Jackson	7	1	14.29%	0	0.00%
Jasper	11	0	0.00%	0	0.00%
Jay	5	2	40.00%	0	0.00%
Jefferson	16	3	18.75%	0	0.00%
Jennings	19	2	10.53%	0	0.00%
Johnson	34	10	29.41%	0	0.00%
Knox	9	4	44.44%	0	0.00%
Kosciusko	30	18	60.00%	1	3.33%
La Porte	66	21	31.82%	2	3.03%
Lagrange	9	5	55.56%	1	11.11%
Lake	125	3	2.40%	0	0.00%
Lawrence	28	5	17.86%	1	3.57%
Madison	27	10	37.04%	0	0.00%
Marion	115	43	37.39%	3	2.61%
Marshall	3	0	0.00%	0	0.00%
Martin	5	0	0.00%	0	0.00%
Miami	28	15	53.57%	1	3.57%
Monroe	30	9	30.00%	1	3.33%
Montgomery	21	11	52.38%	0	0.00%
Morgan	7	3	42.86%	0	0.00%
Newton	12	4	33.33%	0	0.00%
Noble	20	10	50.00%	0	0.00%
Ohio	4	0	0.00%	0	0.00%
Orange	11	4	36.36%	1	9.09%
Owen	5	1	20.00%	0	0.00%
Parke	7	0	0.00%	0	0.00%
Perry	3	0	0.00%	0	0.00%
Pike	8	0	0.00%	0	0.00%
Porter	84	16	19.05%	0	0.00%
Posey	6	1	16.67%	0	0.00%
Pulaski	5	0	0.00%	0	0.00%
Putnam	6	0	0.00%	0	0.00%
Randolph	9	5	55.56%	0	0.00%
Ripley	6	0	0.00%	0	0.00%
Rush	1	0	0.00%	0	0.00%
Scott	21	2	9.52%	0	0.00%
Shelby	7	3	42.86%	0	0.00%
Spencer	11	1	9.09%	0	0.00%
St Joseph	114	30	26.32%	2	1.75%
Starke	8	0	0.00%	0	0.00%
Steuben	13	9	69.23%	0	0.00%
Sullivan	12	1	8.33%	0	0.00%
Switzerland	2	0	0.00%	0	0.00%
Tippecanoe	39	19	48.72%	2	5.13%
Tipton	5	1	20.00%	0	0.00%
Union	0	0	0.00%	0	0.00%
Vanderburgh	32	6	18.75%	0	0.00%
Vermillion	8	4	50.00%	1	12.50%
Vigo	34	15	44.12%	1	2.94%
Wabash	15	9	60.00%	0	0.00%
Warren	4	1	25.00%	1	25.00%
Warrick	21	1	4.76%	0	0.00%
Washington	10	3	30.00%	0	0.00%
Wayne	18	12	66.67%	1	5.56%
Wells	7	1	14.29%	0	0.00%
White	16	2	12.50%	0	0.00%
Whitley	23	10	43.48%	0	0.00%

SOURCE EPA Map of Radon Zones Indiana (September 1993)

This EPA/State survey was conducted in Indiana during the winters of 1986-88. Over 1,989 homes were tested with short-term (2-7 day) charcoal canisters placed in the lowest livable area of the home. These tests determine the radon concentration, measured in pCi/L (picocuries per liter). The average radon concentration measurement in the U.S. is between 1 and 2 pCi/L. The EPA has established the guideline of 4 pCi/L as an "elevated" indoor radon level.

NOTE: The sample size in each county may not be sufficient to show statistical significance. This information is NOT intended to determine if a property in a given county should be tested for radon. If or when radon is a concern, all properties should be tested regardless of the county statistics.

Environmental Glossary

Acid
A large class of substances having a pH less than seven. An acid waste is considered hazardous when the pH is 2.0 or less.

Acute Effect
An adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis.

Acute Exposure
A dose that is delivered to the body in a single event or in a short period of time.

Aerobic
Occurring in the presence of free oxygen.

Alkaline
A substance with a pH between 7 and 14. An alkaline waste is considered hazardous when its pH is 12.5 or greater.

Ambient
Existing conditins of air, water, and other media at a particular time.

Anaerobic
Occurring in the absence of oxygen.

Assessment
An analysis or examination.

Background Environmental Sample
Samples that are considered to contain no contaminants or known concentrations of contaminants.

Base
A substance which forms a salt when reacted with an acid. Bases have a pH of greater than seven.

Buffer Zone
An area of land which surrounds a hazardous waste facility and on which certain land uses and activities are restricted to protect the public health and safety and the environment from existing or potential hazards caused by the migration of hazardous waste (CH&SC Sec. 25110.3).

Carcinogen
A substance or agent capable of causing or producing cancer in mammals.

Caustics
A large class of substances which form solutions having a high pH.

Chronic Effect
An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which reoccur frequently.

Chronic Exposure
Low doses repeatedly received by the body over a long period of time.

Combustible
A term used by the NFPA, DOT, and others to classify certain liquids that will burn, on the basis of flash points. Both the NFPA and DOT generally define "combustible liquids" as having a flash point of 100° F or higher.

Concentration
The relative amount of a substance when combined or mixed with other substances.

Contingency Plan
A document setting out an organized, planned, and coordinated course of action to be followed in case of a fire or explosion or release of a hazardous waste from a TSD or a generator's facility that could threaten human health or the environment (RCRA).

Corrosive
As defined by DOT, a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or in the case of leakage from its packaging a liquid that has a severe corrosion rate on steel. A solid or liquid which exhibits these characteristics can be regulated as hazardous waste.

Decomposition
Breakdown of material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into elements or simpler compounds.

Decontamination
The process of removing contaminants from individuals and equipment.

Deep Well Injection
Disposal of wastes by injecting them into a geological formation deep in the ground, sometimes after pretreatment to avoid solidification.

EPA ID Number
This unique number assigned by EPA to each generator, transporter, or TSD.

Effluent
Waste material, either treated or untreated, discharged into the environment.

Environmental Assessment
The measurement or prediction of the transport, dispersion, and final location of a hazardous substance when released into the environment.

Environmental Emergencies
Incidents involving the release (or potential release) of hazardous materials into the environment which require immediate remedial action.

Environmental Hazard
A condition capable of posing risk of exposure to air, water, soil, plants, or wildlife.

Exception Report
A report that generators who transport waste off-site must submit if they do not receive a properly completed copy of their manifest within 45 days of the date on which the initial transporter accepted the waste.

Generator
The person or facility who, by nature or ownership, management or control, is responsible for causing or allowing to be caused, the creation of hazardous waste.

Glovebag
A device used to remove a section of pipe insulation without isolating the entire space or room.

Groundwater Hydrology
The study of the movement of water below the earth's surface.

Hazard
A circumstance or condition that can cause harm. Hazards are often categorized into four groups: biological, chemical, physical, and radiation.

Hazard Classes
A series of nine descriptive terms that have been established by the UN Committee of Experts to categorize the hazardous nature of chemical, physical, and biological materials. These categories are: flammable liquids, explosives, gases, oxidizers, radioactive materials, corrosives, flammable solids, poisonous and infectious substances, and dangerous substances.

Hazardous Waste
Any material that is subject to the hazardous waste manifest requirements of the EPA specified in the CFR, Title 40, Part 262 or would be subject to these requirements in the absence of an interim authorization to a State under CFR, Title 40, Part 123, Subpart F.

Heavy Metals
Certain metallic elements having a high density and generally toxic, e.g., lead, silver, mercury, and arsenic.

Immediate Removal
Actions undertaken to prevent or mitigate immediate and significant risk of harm to human life or health or the environment. As set forth in the National Contingency Plan, these actions shall be terminated after $1 million has been obligated or six months have elapsed from the date of initial response.

Incident
The release or potential release of a hazardous substance into the environment.

Inert
Exhibiting no chemical activity; totally unreactive.

Innocent Land Owner's Defense
The defense of a purchaser of real property that he or she exercised due diligence in having hazards assessed prior to purchase.

Interim Status
Allows owners and operators of TSDs that were in existence, or for which construction had commenced, prior to November 19, 1980 to continue to operate without a permit after this date pending final issuance from RCRA.

Joint and Several Liability
Under federal law each party that contributed to damages may be held liable for all damages, but each has the right to compel the others to contribute and indemnify.

Liability
Being subject to legal action for one's behavior.

MSDS Material Safety Data Sheet
Required by OSHA of owners to alert employees to hazards, their effect, and protective action.

Manifest
Form which indicates generator, quantity, and type of waste for each shipment of hazardous wastes disposed in off-site facilities.

National Contingency Plan
Policies and procedures that the Federal Government follows in implementing responses to incidents involving hazardous substances.

P Wastes
A federal waste list comprised of substances categorized as acutely hazardous.

Part A
The first part of a two part application that must be submitted by a TSD to receive a permit. It contains general facility information.

Part B
The second part of a two part application that must be submitted by a TSD to receive a permit. It contains highly technical and detailed information.

Planned Removal
The removal of released hazardous substances from the environment within a non-immediate, long term time period. Under CERCLA: Actions intended to minimize increases in exposure such that time and cost commitments are limited to six months and/or $1 million.

Poison, Class A
A DOT term for extremely dangerous poisons, that is, poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. Some examples: phosgene, cyanogen, and hydrocyanic acid.

Poison, Class B
A DOT term for liquid, solid, paste, or semisolid substances, other than Class A poisons, which are known to be toxic to man as to afford a hazard to health during transportation.

Pollutant
A substance or mixture which after release into the environment and upon exposure to any organisms will or may reasonably be anticipated to cause adverse effects in such organisms and their offspring.

Priority Pollutants
A list of chemicals selected from the list of toxic pollutants by the EPA as priority toxic pollutants for regulation under the Clean Water Act.

Remedial Actions
Responses to releases of hazardous substances on the NPL that are consistent with a permanent remedy which would prevent or mitigate the migration of materials into the environment.

Risk
The probability that an unwanted event will occur.

Second Responders
Those personnel required to assist or relieve first responders at a hazardous material incident due to their specialized knowledge, equipment, or experience. These include State environmental protection or health officials, commercial response, cleanup companies, and appropriate industry representatives.

Strict Liability
Holds a party responsible for damages irrespective of the amount of care taken in handling a hazardous substance.

Subtitle C
The part of RCRA which pertains to the management of hazardous waste.

Subtitle I
The part of RCRA which pertains to the storage of petroleum products and hazardous substances, other than wastes, in USTs.

Superfund
See CERCLA.

Synergistic
The action of two materials together which is greater in effect than the sum of the individuals actions.

TIGER Files
The US Census Bureau's TIGER files provide a nationwide computerized map with address range information.

Tort
A legal wrong, sometimes referred to as negligence.

Toxicity
The ability of a substance to produce injury by non-mechanical means once it reaches a susceptible site in or on the body.

U Wastes
A federal list of hazardous wastes which consists of substances deemed to be hazardous for hazards other than acute hazards.

-- Adapted from Lincoln Graduate Center, 1993. Real Estate Environmental Screening. San Antonio, Texas.

Acronyms and Abbreviations

-AIRS	Aerometric Information Retrieval System
-AST	Aboveground Storage Tank
-ASTM	American Society for Testing and Materials
-BLM	Bureau of Land Management
-BNA	Bureau of National Affairs
-CAA	Clean Air Act
-CDC	Centers for Disease Control
-CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
-CERCLIS	CERCLA Information System
-CICIS	Chemicals in Commerce Information System
-COE	U.S. Army Corps of Engineers
-CWA	Clean Water Act
-DDT	Dicholoro-diphenyl-dichloroethane
-DOC	Department of Commerce
-DOCKET	Enforcement Docket System--Office of Enforcement and Compliance Monitoring
-DOE	Department of Energy
-DOT	Department of Transportation
-EPA	Environmental Protection Agency
-ERCS	Emergency Response Cleanup Services
-ERNS	Emergency Response Notification System
-ESA	Environmental Site Assessment
-FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
-FINDS	Facility Index System
-FOIA	Freedom of Information Act
-FWPCA	Federal Water Pollution Control Act
-HHS	Department of Health and Human Services
-HSWA	Hazardous and Solid Waste Amendments of 1984
-HUD	Department of Housing and Urban Development
-LUST	Leaking Underground Storage Tank
-MSDS	Material Safety Data Sheet
-NEPA	National Environment Policy Act
-NESHAP	National Emission Standards for Hazardous Air Pollutants
-NFRAP	No Further Remedial Action Planned (Delisted CERCLA Site)
-NOI	Notice of Intent
-NOV	Notice of Violation
-NPDES	National Pollution Discharge Elimination System
-NPL	National Priorities List
-NRC	Nuclear Regulatory Commission
-NRIS	Nuclear Regulatory Information System
-OSHA	Occupational Safety and Health Administration

Acronyms and Abbreviations

-PADS	PCB Activity Database System
-PCB	Polychlorinated Biphenyls
-POTW	Publicly-Owned Treatment Works
-PPM	Parts Per Million
-PRP	Potentially Responsible Parties
-RAATS	RCRA Administrative Action Tracking System
-RCRA	Resource Conservation and Recovery Act of 1976
-RCRIS	Resource Conservation and Recovery Information System
-RFA	RCRA Facility Assessment
-RFI	RCRA Facility Investigation
-RI	Remedial Investigation (CERCLA)
-SARA	Superfund Amendments and Reauthorization Act of 1986
-SCS	Soil Conservation Service
-SDWA	Safe Drinking Water Act
-SETS	Superfund Enforcement Tracking System
-SSTS	Section Seven Tracking System
-SWF/LF	Solid Waste Facilities / Landfills
-TIGER	Topologically Integrated Geographic Encoding and Referencing System
-TRI	Toxic Release Inventory
-TSCA	Toxic Substances Control Act
-TSD	Treatment, Storage, or Disposal Facility
-USDA	U.S. Department of Agriculture
-USGS	U.S. Geological Survey
-UST	Underground Storage Tank
-WWTP	Wastewater Treatment Plant

APPENDIX G

Silver Creek Government Records Review

EcoSearch Environmental Resources, Inc.
8606 Allisonville Road, Suite 300
Indianapolis, Indiana 46250
ph: (317) 577-9797 fax: (317) 577-9191

EcoSearch

Government Records Search

Type of Report:	Priority Risk Report
Site Location:	Silver Creek Watershed Liberty, IN 47353
Date:	April 3, 2001
Report ID Number:	2276-7101
Especially Prepared For:	Mr. Kent Shadley Sagamore Environmental Service
Project #:	00-0681M

Limits of Information:
Customer proceeds at its own risk in choosing to rely on EcoSearch Environmental Resources, Inc. ("EcoSearch") services, in whole or in part, prior to proceeding with any transaction. EcoSearch cannot be an insurer of the accuracy of the information, errors occurring in the conversion of data, or for customer's use of the data. EcoSearch and its affiliated companies, officers, agents, employees, and independent contractors cannot be held liable for accuracy, storage, delivery, loss, or expense suffered by the customer resulting directly or indirectly from any information provided by EcoSearch Environmental Resources, Inc.

Thank you for choosing EcoSearch.

Introduction

We want to thank you for your order requesting the enclosed site assessment.

EcoSearch makes every effort possible to combine the most accurate environmental data available into an understandable and easy-to-use format.

While every attempt has been made to ensure accuracy of the information presented, we cannot guarantee the accuracy of the data from the original sources, nor can we guarantee that no transcription or plotting errors have occurred.

If any concerns arise from your review of the databases in this report, please call the appropriate agency involved. As a service, we have included phone numbers in the database description section of this report to help you in your evaluation.

The enclosed maps present a working approximation of the location of surrounding environmental sites based primarily on available accurate site addresses. These maps should not be used for purposes more correctly handled by surveys.

EcoSearch is driven by its mission to present the most responsive, technically sound, and cost-effective environmental data services available to our customer.

Read Me First

The following suggestions are offered in an attempt to help you in using and understanding this site assessment from EcoSearch:

1. Skim over the entire report to familiarize yourself with its contents and layout.

2. You will notice that the information is presented following this general concept: we begin by giving sections that summarize data and then give detailed information about these summaries as you proceed further into the report.

3. Then refer to the section titled "Statistical Overview". You will need to take a moment to read the column headings and the data below them. Also, as you go down the first column (left side) you will probably need to look back at the preceeding section titled "Database Descriptions". Please pay particular attention to the radius searched as they vary according to the database. These are ASTM standards that we meet and exceed. Your site's datum is the third, shaded column. Also, the next column showing database hits within the first radius is important as it will include data about adjoining properties. The unmappable sites have their own section with a cover page explaining them.

4. The next section titled "Maps" is important as it gives a very clear visual presentation of the site, and which database(s) are at the site itself or within the study radii.

5. The site summary page(s) tells you by map ID# which database is at that location as well as the site's name and distance/direction from your study site. You will notice that the numbering corresponds to the distance from the subject site-- eg. #1 is your site itself or the site closest to it, #2 is further away. This continues until all database hits have been summarized within the largest study radius. Your report may extend further than one mile if you asked us to extend the radii.

6. As you will recall our format goes from summary-type pages to detailed information. Therefore, the next section is "Detailed Data". Here extensive data is given about each database hit. The map ID#, distance, and direction are in the top left corner. Further data follows.

7. The "Unmappable" section was referred to earlier. In this summary you will find those sites. Please read the cover page as it describes unmappable sites and our efforts to minimize and/or eliminate them from all of our site assessments.

8. The last two divisions -- "Radon" and "Glossary/Acronyms" are self-explanatory and often helpful to our customers.

If you would like further help in understanding our reports please call as our intention is to have this report helpful to you.

Database Descriptions -- Federal Databases

NPL

National Priorities List

US Environmental Protection Agency	Data Date: December 29, 2000
Office of Solid Waste and Emergency Response	Release Date: December 29, 2000
(703) 603-8881	Active Date: January 26, 2001
	Last Contact Date: January 26, 2001

The NPL is a subset of the CERCLIS and lists over 1,150 of the nation's most dangerous sites of uncontrolled or hazardous waste which require cleanup. Also known as the Superfund List, the sites are scored according to the hazardous ranking system.

CERCLA (Active)

Comprehensive Environmental Response, Compensation, and Liability Information System (Active)

US Environmental Protection Agency	Data Date: December 29, 2000
Office of Solid Waste and Emergency Response	Release Date: December 29, 2000
1-800-775-5037	Active Date: January 26, 2001
	Last Contact Date: January 26, 2001

CERCLIS maintains information on over 15,000 sites nationally identified as hazardous or potentially hazardous which may require action. These sites are currently being investigated or an investigation has been completed regarding the release of hazardous substances. The most serious of this list as ranked by the hazardous ranking system are transferred to the NPL.

CERCLA (NFRAP Archive)

Comprehensive Environmental Response, Compensation, and Liability Information System (NFRAP Archive)

US Environmental Protection Agency	Data Date: December 29, 2000
Office of Solid Waste and Emergency Response	Release Date: December 29, 2000
1-800-775-5037	Active Date: January 26, 2001
	Last Contact Date: January 26, 2001

For more complete information purposes we include sites which have been reclassified as No Further Remedial Action Planned (NFRAP) by the EPA. This action was taken by the EPA beginning February 1995 as a part of the Brownfields Redevelopment Program. These former CERCLIS sites, also known as the CERCLIS Archive, have been delisted because a lack of significant contamination was found.

RCRA TSD

Resource Conservation and Recovery Information System – Treatment, Storage, and Disposal Facilities

US Environmental Protection Agency	Data Date: April 15, 2000
Office of Solid Waste and Emergency Response	Release Date: April 15, 2000
(202) 260-4610	Active Date: August 7, 2000
	Last Contact Date: January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The TSD database is a subset of the complete RCRIS file which includes facilities which treat, store, dispose, or incinerate hazardous waste. Additionally, compliance and corrective action (CORRACTS) information is included.

RCRA LQ Generator

Resource Conservation and Recovery Information System -- Large Quantity Generator

US Environmental Protection Agency
Office of Solid Waste and Emergency Response
(202) 260-4610

Data Date: April 15, 2000
Release Date: April 15, 2000
Active Date: August 7, 2000
Last Contact Date: January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The generators database is a subset of the complete RCRIS file which includes hazardous waste generators which create more than 1000kg of hazardous waste per month or meet other requirements of RCRA.

RCRA SQ Generator

Resource Conservation and Recovery Information System -- Small Quantity Generator

US Environmental Protection Agency
Office of Solid Waste and Emergency Response
(202) 260-4610

Data Date: April 15, 2000
Release Date: April 15, 2000
Active Date: August 7, 2000
Last Contact Date: January 18, 2001

RCRIS contains information on hazardous waste handlers regulated by the US Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA). It is a national system used to track events and activities which fall under RCRA. The generators database is a subset of the complete RCRIS file which includes hazardous waste generators which create more than 100kg and less than 1000kg of hazardous waste per month or meet other requirements of RCRA.

CORRACTS

Resource Conservation and Recovery Information System -- Corrective Action Sites

US Environmental Protection Agency
Office of Solid Waste and Emergency Response
(202) 260-4610

Data Date: April 15, 2000
Release Date: April 15, 2000
Active Date: August 7, 2000
Last Contact Date: January 18, 2001

The CORRACTS database includes RCRIS (Resource Conservation and Recovery Information System) sites with reported corrective action. This information is also reported in the standard RCRIS detailed data.

ERNS

Emergency Response Notification System

US Environmental Protection Agency
Office of Solid Waste and Emergency Response
(202) 260-2342

Data Date: January 1, 2000
Release Date: January 1, 2000
Active Date: March 17, 2000
Last Contact Date: January 18, 2001

ERNS is a national database which contains information on specific notification of releases of oil and hazardous substances into the environment. The system stores data regarding the site of the spill, the material released, and the medium into which it occured.

PCS

Permit Compliance System (NPDES Data)

US Environmental Protection Agency	Data Date:	October 15, 1997
	Active Date:	October 15, 1997

The Permit Compliance System Database contains information on permitted discharge information from the National Pollutant Discharge Elimination System.

Database Descriptions -- State Databases

SCL (HWS)

Indiana State Cleanup List

Indiana Department of Environmental Management	Data Date:	December 8, 1998
Office of Environmental Response	Release Date:	December 8, 1998
(317) 308-3008	Active Date:	June 15, 1999
	Last Contact Date:	March 7, 2001

This database identified sites deemed by the State of Indiana for remediation. It also includes sites designated for immediate removal, voluntary cleanup, and hazardous ranked sites listed on the IDEM Commissioner's Bulletin No. 6 (dated 12/10/95).

SWF

Indiana Permitted Solid Waste Facilities

Indiana Department of Environmental Management	Data Date:	February 16, 2000
Office of Solid Waste Management	Release Date:	February 16, 2000
(317) 232-3399	Active Date:	February 29, 2000
	Last Contact Date:	February 22, 2001

This state database lists sites which are regulated for solid waste disposal by the State of Indiana. It is updated twice a year by the Office of Solid Waste Management.

LUST

Indiana Leaking Underground Storage Tank List

Indiana Department of Environmental Management	Data Date:	January 8, 2001
	Release Date:	January 8, 2001
(317) 308-3008	Active Date:	January 13, 2001
	Last Contact Date:	March 7, 2001

The IDEM LUST list contains information on underground storage tanks with reported releases into the environment. Agency Required Disclaimer: This information is an unconfirmed, non-verified list of reported notifications or releases at facilities or sites. It should not be used for or considered as a final Agency determination of whether proper notification, actual releases, or the completion of remedial activities have occurred. In providing this list, the Agency makes no representation regarding the accuracy of the information.

UST

Indiana Registered Underground Storage Tank List

Indiana Department of Environmental Management	Data Date:	January 8, 2001
Underground Storage Tank Branch	Release Date:	January 8, 2001
(317) 308-3008	Active Date:	January 13, 2001
	Last Contact Date:	March 6, 2001

The Indiana UST list provides the location of registered underground storage tanks. Agency Required Disclaimer: This information is an unconfirmed, non-verified list of reported notifications or releases at facilities or sites. It should not be used for or considered as a final Agency determination of whether proper notification, actual releases, or the completion of remedial activities have occurred. In providing this list, the Agency makes no representation regarding the accuracy of the information.

SPILL

Indiana Spills Database

Indiana Department of Environmental Management	Data Date:	January 13, 2000
	Release Date:	January 13, 2000
(317) 308-3023	Active Date:	March 8, 2000
	Last Contact Date:	March 1, 2001

The Indiana Spills Database contains information about reported hazardous materials spills and fish kills in the State of Indiana.

USPILL

Indiana Union County Spills Data

Union County Emergency Management	Data Date:	January 2001
765-458-9504	Active Date:	March 7, 2001
	Last Contact Date:	March 7, 2001

The Indiana Union County Spills Database contains information about reported hazardous material spills in the county of Union.

CFO

Indiana Confined Feeding Operations

Indiana Department of Environmental Management	Data Date:	January 2001
Office of Land Quality		
317-232-3529	Active Date:	March 8, 2001
	Last Contact Date:	March 7, 2001

Confined feeding is the raising of animals for food, fur or recreation in lots, pens, ponds, sheds or buildings, where they are confined, fed and maintained for at least 45 days during any year, and where there is no ground cover or vegetation present over at least half of the animals' confinement area. Livestock markets and sale barns are generally excluded. Indiana law defines a confined feeding operation as any livestock operation engaged in the confined feeding of at least 300 cattle, or 600 swine or sheep, or 30,000 fowl, such as chickens, ducks and other poultry. The Indiana Department of Environmental Management (IDEM) regulates these confined feeding operations, as well as smaller livestock operations which have violated water pollution rules or laws, under IC 13-18-10, the Confined Feeding Control Law.

EcoSearch Statistical Overview

Property Information	Search Parameters
Silver Creek Watershed Liberty, IN 47353 Latitude: 39.670023 N Longitude: 84.894139 W	Report: Priority Risk Report Radii: ASTM* Zip Code(s): 47353 City: Liberty Harrison Center County: Union

FEDERAL DATABASES	Radius (miles)	Mappable Sites						Unmappable Sites		
		Total	Site	Area Vicinity**	within 0.00mi	0.00 - 0.00mi	0.00 - 0.00mi	Zip Code	City	County
NPL	Site	0	0	0	-	-	-	0	0	0
CERCLA (Active)	Site	0	0	0	-	-	-	0	0	0
CERCLA (NFRAP Archive)	Site	0	0	0	-	-	-	0	0	0
RCRA TSD	Site	0	0	0	-	-	-	0	0	0
RCRA LQ Generator	Site	1	0	1	-	-	-	0	0	0
RCRA SQ Generator	Site	2	0	2	-	-	-	0	0	0
CORRACTS	Site	0	0	0	-	-	-	0	0	0
ERNS	Site	0	0	0	-	-	-	-	-	-
PCS	Site	1	0	1	-	-	-	0	0	0

STATE DATABASES	Radius (miles)	Mappable Sites						Unmappable Sites		
		Total	Site	Area Vicinity**	within 0.00mi	0.00 - 0.00mi	0.00 - 0.00mi	Zip Code	City	County
SCL (HWS)	Site	0	0	0	-	-	-	0	0	0
SWF	Site	2	0	2	-	-	-	0	0	0
LUST	Site	4	0	4	-	-	-	1	0	0
UST	Site	16	0	16	-	-	-	1	-	-
SPILL	Site	8	0	8	-	-	-	0	-	-
USPILL	Site	4	0	4	-	-	-	0	0	0
CFO	Site	0	0	0	-	-	-	0	0	0

MANUAL GEOCODING:^	For this city/township,	58	sites were manually plotted by EcoSearch.

* This database search and study radii meets or exceeds the ASTM (American Society of Testing and Materials) standards for a government records review.

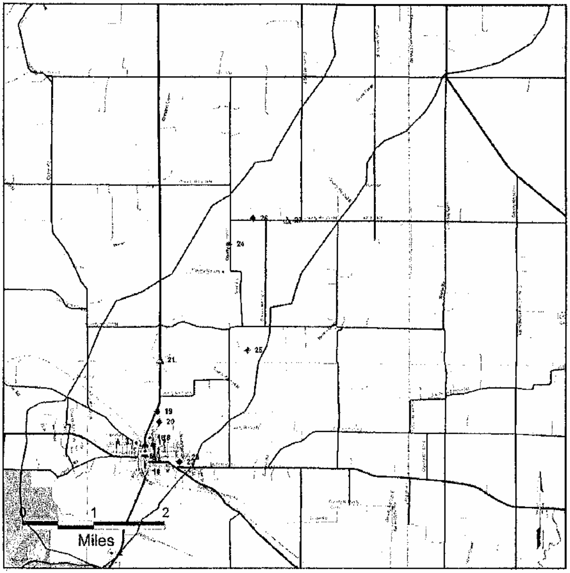
** Area Vicinity indicates that Environmental Area Records were found near your study site. These records detail contamination or other environmental conditions in a wide area which cannot be placed to a single point or more precisely plotted. More research is necessary to determine the possible environmental impact of these Area Records to your study site.

^ Manual Geocoding: Plotting environmental site data using paper maps and phone calls to properly place the information on the map.

Accurate street addresses are required for records to be found at the study property.

Mappable Sites are environmental sites which were located and appear on the enclosed EcoSearch Map, Site Summary, and Detailed Data sections of the report. These sites are summarized based on proximity to the study site.

Unmappable Sites are governmental records with incomplete or inaccurate address information. These sites could not be located on the street map, but have been searched by the Zip Codes, Cities, and County specified in the search parameters. Further investigation of these sites and their relationship to your study site is necessary.



EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353

Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

MULTIPLE MATCHES / AREAS

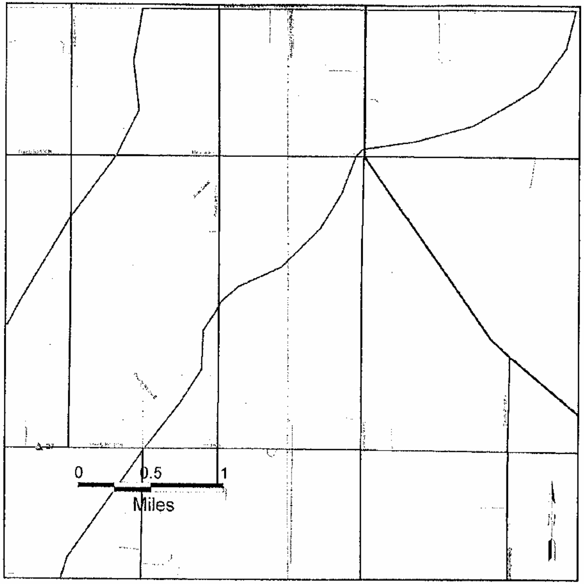
- Two Database Matches
- Three or More Matches
- Database Area Site

MAP LEGEND

Parks	Streets
Incorp. Areas	Secondary Roads
Water	Primary Roads
Cemeteries	Freeways
	Railroads
	Boundaries

Radii:

Note. The information contained on this map is subject to the general disclaimer on the first page.



Note: The information contained on this map is subject to the general disclaimer on the first page.

EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353

Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

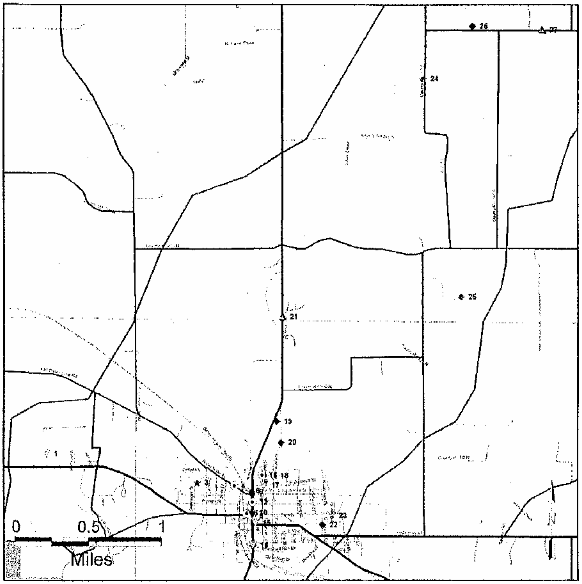
MULTIPLE MATCHES / AREAS

Two Database Matches
Three or More Matches
Database Area Site

MAP LEGEND

Parks
Incorp. Areas
Water
Cemeteries
Streets
Secondary Roads
Primary Roads
Freeways
Railroads
Boundaries

Radii:



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EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353

☐ Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

MULTIPLE MATCHES / AREAS

- Two Database Matches
- Three or More Matches
- Database Area Site

MAP LEGEND

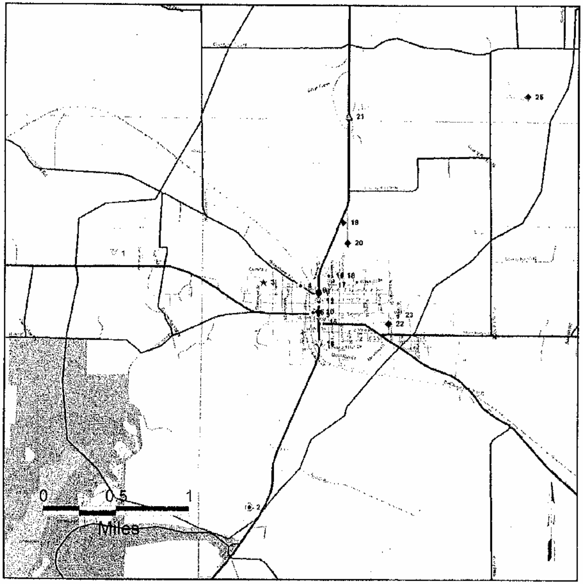
Parks	Streets
Incorp. Areas	Secondary Roads
Water	Primary Roads
Cemeteries	Freeways
	Railroads
	Boundaries

Radii:

EcoSearch Environmental Resources, Inc.

Priority Risk Report Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353



Study Area

FEDERAL DATABASES	Radius (mi)
NPL Sites	Site
CERCLA (Active) Sites	Site
CERCLA (NFRAP Archive) Sites	Site
RCRA TSD Sites	Site
RCRA LQ Generator Sites	Site
RCRA SQ Generator Sites	Site
CORRACTS Sites	Site
ERNS Sites	Site
PCS Sites	Site
STATE DATABASES	
SCL (HWS) Sites	Site
SWF Sites	Site
LUST Sites	Site
UST Sites	Site
SPILL Sites	Site
USPILL Sites	Site
CFO Sites	Site

MULTIPLE MATCHES / AREAS

Two Database Matches
Three or More Matches
Database Area Site

MAP LEGEND

Parks
Incorp. Areas
Water
Cemeteries
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Secondary Roads
Primary Roads
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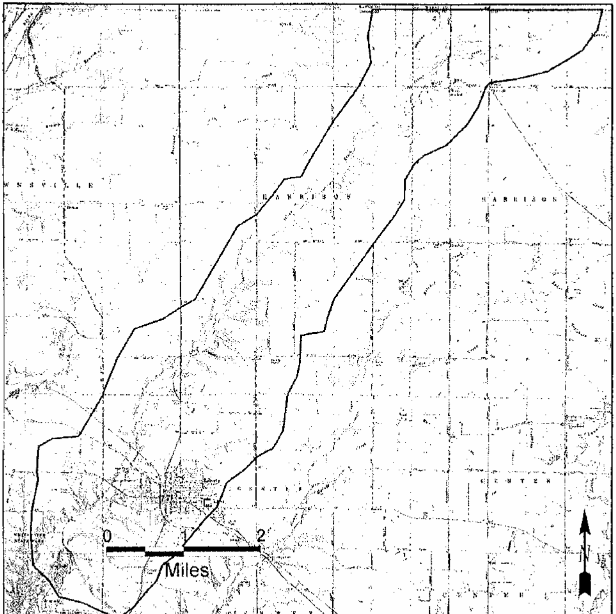
Radii:

Note: The information contained on this map is subject to the general disclaimer on the first page



Source: United States Geological Survey, 7.5 minute Topographic Map (Digital Raster Graphics)

EcoSearch Environmental Resources, Inc.

USGS 7.5 Minute Topographical Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353

○ Target Area

Map Features are Color Coded

Black -- Cultural features such as roads and buildings.

Blue -- Hydrographic features such as lakes and rivers.

Brown -- Hypsographic (elevation) features shown by contour lines.

Green -- Woodland cover, scrub, orchards, and vineyards.

Red -- Important roads and public land survey system.

Purple -- Features added from aerial photographs during map revision. The changes are not field checked.

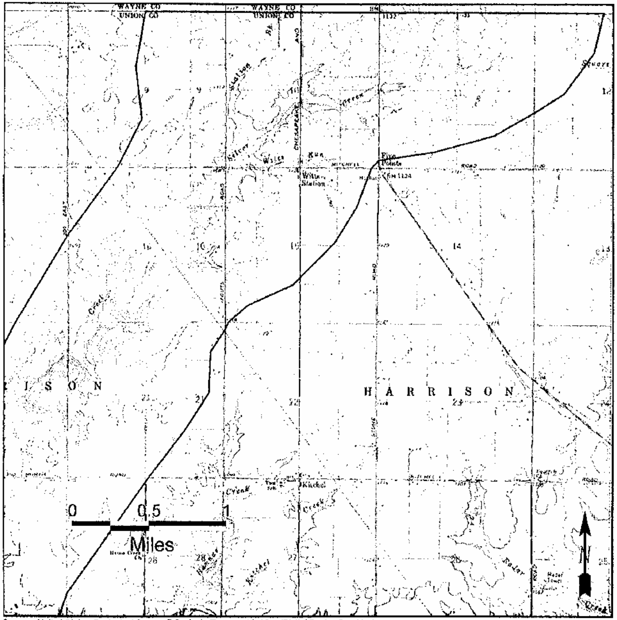
A detailed Topographic Map Symbols pamphlet is available from EcoSearch free upon request.

Radii: 0.25 mile, 0.50 mile, 1.00 mile

Topographical Maps:

Liberty, IN -- 1974

Fairhaven, OH IN -- 1960



Source: United States Geological Survey, 7.5 minute Topographic Map (Digital Raster Graphics)

EcoSearch Environmental Resources, Inc.

USGS 7.5 Minute Topographical Map

Report ID: 2276-7101
Site: Silver Creek Watershed
Liberty, IN 47353

○ Target Area

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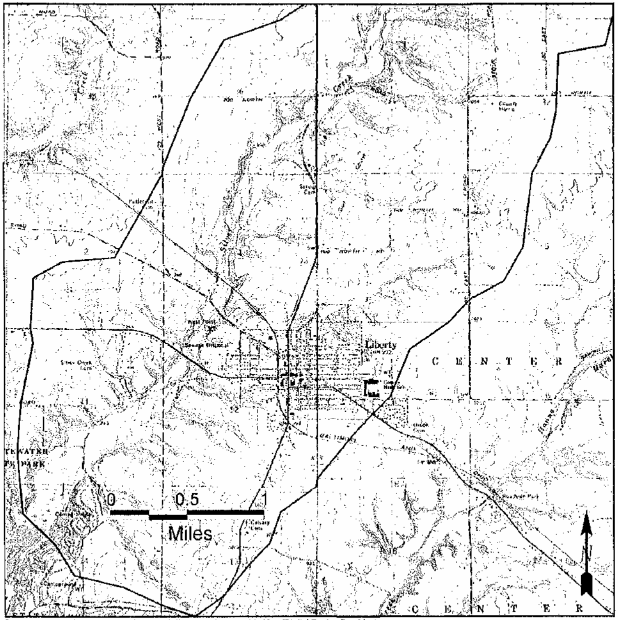
Topographical Maps:
Liberty, IN -- 1974
Fairhaven, OH IN -- 1960



Source: United States Geological Survey, 7.5 minute Topographic Map (Digital Raster Graphics)

EcoSearch Environmental Resources, Inc.

USGS 7.5 Minute Topographical Map

Report ID:
Site:

A detailed Topographic Map Symbols pamphlet is available from EcoSearch free upon request.

Radii: 0.25 mile, 0.50 mile, 1.00 mile

Topographical Maps:
Liberty, IN -- 1974
Fairhaven, OH IN -- 1960

Site Summary

Map ID#	Database / Agency ID#	Site Name, Address, and County	Distance/Direction
1	SPILL Indiana Spills Database Site 9105052	UNKNOWN 1 MI W OF LIBERTY N OF 44 LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*
2A	UST Indiana Underground Storage Tank 20607	FRAME'S OUTDOOR SPORTS RR 1 LIBERTY, IN 47353-9801 UNION	0.00000 mi Manually Geocoded*
2B	UST Indiana Underground Storage Tank 17058	FRAME'S OUTDOOR SPORTS SUPPLIES RR 2 BOX 202A LIBERTY, IN 47353-9537 UNION	0.00000 mi Manually Geocoded*
3	PCS Permit Compliance System Database IN0020681	LIBERTY MUNICIPAL WWTP SR 44 DEWEY ST LIBERTY, IN 47353 UNION	0.00000 mi Agency Provided Lat/Long**
4A	SPILL Indiana Spills Database Site 9903176	D AND L INDUSTRIAL FINISHES 215 BROWNSVILLE AVE LIBERTY, IN 47353-1002 UNION	0.00000 mi
4B	RCRA Generator RCRA Large Quantity Generator IND006036792	D&L INDUSTRIAL FINISHES INC 215 BROWNSVILLE AVE LIBERTY, IN 47353-1002 UNION	0.00000 mi
5A	UST Indiana Underground Storage Tank 19323	SEE FID 009473 3 N RAILROAD ST LIBERTY, IN 47353-1031 UNION	0.00000 mi Manually Geocoded*
5B	UST Indiana Underground Storage Tank 9473	LIBERTY OIL CO 3 N RAILROAD ST LIBERTY, IN 47353-1031 UNION	0.00000 mi Manually Geocoded*
6	SPILL Indiana Spills Database Site 8905123	HAROLD SCAGGS NORTH MAIN & BROWNSVILLE RD LIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*
7	UST Indiana Underground Storage Tank 1121	SS #20268 MAIN & SYCAMORE LIBERTY, IN 47353 UNION	0.00000 mi
8	UST Indiana Underground Storage Tank 9035	JOHNSON'S SERVICE 206 N MAIN ST LIBERTY, IN 47353-1010 UNION	0.00000 mi Manually Geocoded*
9A	SPILL Indiana Spills Database Site 9602199	TIM WOODRUFF 10 S MAIN ST LIBERTY, IN 47353-1341 UNION	0.00000 mi -
9B	LUST Indiana Leaking Underground Storage Tank 199602199	RICHARDSON SUNOCO 10 S MAIN ST LIBERTY, IN 47353-1341 UNION	0.00000 mi
9C	UST Indiana Underground Storage Tank 7412	RICHARDSON SUNOCO 10 S MAIN ST LIBERTY, IN 47353-1341 UNION	0.00000 mi

Site Summary

Map ID#	Database / Agency ID#	Site Name, Address, and County	Distance/Direction
10	UST Indiana Underground Storage Tank 10991	HERDRICH PETROLEUM LIBERTY SHELL 10 N MAIN ST LIBERTY, IN 47353-1027 UNION	0.00000 mi
11	UST Indiana Underground Storage Tank 16531	SCAGGS OIL CO 110 N MAIN ST LIBERTY, IN 47353-1029 UNION	0.00000 mi - Manually Geocoded*
12A	UST Indiana Underground Storage Tank 8959	UNION 76 LIBERTY CARTER'S SERVICE 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi Manually Geocoded*
	LUST Indiana Leaking Underground Storage Tank 199403534	UNION 76 LIBERTY CARTER'S SERVICE 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi Manually Geocoded*
	SPILL Indiana Spills Database Site 9906166	KIEL BROS. OIL CO. 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi Manually Geocoded*
12D	USPILL Indiana Union County Spills Data UNSPIL4	101 N. MAIN ST. 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi - Manually Geocoded*
	SPILL Indiana Spills Database Site 9810115	B & C ONE STOP & SHOP 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi Manually Geocoded*
12F	LUST Indiana Leaking Underground Storage Tank 199911531	UNION 76 LIBERTY CARTER'S SERVICE 101 N MAIN ST LIBERTY, IN 47353-1030 UNION	0.00000 mi Manually Geocoded*
13	UST Indiana Underground Storage Tank 11055	MILES-RICHMOND INC 221 S MAIN ST LIBERTY, IN 47353-1356 UNION	0.00000 mi
14	USPILL Indiana Union County Spills Data UNSPIL3	217 S. MAIN ST. 217 S MAIN ST LIBERTY, IN 47353-1356 UNION	0.00000 mi -
15	USPILL Indiana Union County Spills Data UNSPIL6	SR 27 AND HWY 44 SR 27 AND HWY 44 LIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*
	UST Indiana Underground Storage Tank 6923	UNION COUNTY FARM BUREAU CO-OP 101 W CAMPBELL ST LIBERTY, IN 47353-1143 UNION	0.00000 mi Manually Geocoded*
16B	LUST Indiana Leaking Underground Storage Tank 199903564	UNION COUNTY FARM BUREAU CO-OP 101 W CAMPBELL ST LIBERTY, IN 47353-1143 UNION	0.00000 mi Manually Geocoded*
17	SPILL Indiana Spills Database Site 9307112	GTE 4 E WESTCOTT LIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*

Site Summary

Map ID#	Database / Agency ID#	Site Name, Address, and County	Distance/Direction
18	USPILL Indiana Union County Spills Data UNSPIL1	N. FAIRGROUND & CAMPBELL N. FAIRGROUND & CAMPBELL LIBERTY, IN 47353 UNION	0.00000 mi -
19	UST Indiana Underground Storage Tank 22353	UNION COUNTY EMT SR 27 LIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*
20	UST Indiana Underground Storage Tank 5323	TOWN GARAGE RR 3 LIBERTY, IN 47353-9803 UNION	0.00000 mi Manually Geocoded*
21	RCRA Generator RCRA Small Quantity Generator IND984876201	HOFMANN BODY SHOP 1735 US 27 N LIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*
22	UST Indiana Underground Storage Tank 11693	UNION COUNTY SCHOOL CORP 107 S LAYMAN ST LIBERTY, IN 47353-1203 UNION	0.00000 mi
23	SPILL Indiana Spills Database Site 9310180	UNION COUNTY HIGH SCHOOL HIGHSCHOOL SCIENCE STORAGE LIIBERTY, IN 47353 UNION	0.00000 mi Manually Geocoded*
24	SWF Indiana Solid Waste Facility 81-0002	UNION COUNTY TRANSFER STATION 3 MILES NORTHEAST OF LIBERTY ON CR 100 EAST , IN UNION	0.00000 mi Manually Geocoded*
25	SWF Indiana Solid Waste Facility 81-1	UNION COUNTY LANDFILL C.R. 100E & C.R. 200N UNION, IN UNION	0.00000 mi Manually Geocoded*
26	UST Indiana Underground Storage Tank 3346	HAROLD CROUSE & SONS RR 3 BOX 58 LIBERTY, IN 47353-9410 UNION	0.00000 mi Manually Geocoded*
27	RCRA Generator RCRA Small Quantity Generator IND981799513	KIRK NATIONALEASE 186 KITCHEL RD LIBERTY, IN 47353 UNION	0.00000 mi - Manually Geocoded*

Manually Geocoded: Site plotted or corrected using paper maps, phone calls, and other resources to properly place the site on the map.

Agency Provided Lat/Long: Site plotted using the latitude and longitude given by the federal or state government agency.

Area Manually Plotted: Area manually drawn using digital and paper maps.

Detailed Data

The following pages contain the detailed data concerning the sites plotted on the map and included in the site summary.

Please Note: Pages are not included for databases not found within the search radii.

These pages are arranged as follows:

- RCRA TSD and Generators Data
- PCS Data
- Indiana SWF Data
- Indiana LUST Data
- Indiana UST Data
- Indiana SPILLS Data
- Union Spills Data

RCRA TSD and Generators Data

Facility and Compliance Information

Map ID#: 4B	Distance (mi): 0.000000	Name:	D&L INDUSTRIAL FINISHES INC		
	Direction: -	Address:	215 BROWNSVILLE AVE		
EPA ID#: IND006036792		City, State, Zip:	LIBERTY	IN	47353
Status: Large Quantity Generator					
Land Type: Unknown		SIC Code:	2851		
Record Date: 08/18/1980		Contact Name:	DENVER CORNETT		
Used Oil Recyc Unverified		Contact Phone:	317-458-5157		

RCRA Evaluation / Violation / Enforcement Data

EVALUATIONS

Eval. #:	19871218001	Agency: State		Evaluation Date:	12/18/1987
Enf. #:	19880223001	Agency: State	Type: Written Informal	Date:	02/23/1988
Viol. #:	IND006036792S0001	Violation Type:	Generator - Any Requirements	Actual Resolution Date:	12/01/1989
Eval. #:	19871218003	Agency: State		Evaluation Date:	12/18/1987
Enf. #:	19880317002	Agency: EPA	Type: Written Informal	Date:	03/17/1988
Viol. #:	IND006036792S0002	Violation Type:	Generator - Land Ban Requirement	Actual Resolution Date:	04/28/1988
Eval. #:	19881218004	Agency: State		Evaluation Date:	12/18/1988
Enf. #:	19980716002	Agency: State	Type: Written Informal	Date:	07/16/1998
Viol. #:	IND006036792S0003	Violation Type:	Generator - Any Requirements		
Eval. #:	19891130002	Agency: State		Evaluation Date:	11/30/1989
Enf. #:	19980908004	Agency: State	Type: Written Informal	Date:	09/08/1998
Viol. #:	IND006036792S0004	Violation Type:	Generator - Any Requirements		
Eval. #:	19980227001	Agency: EPA Personnel		Evaluation Date:	02/27/1998
Enf. #:	19980923003	Agency: State	Type: Final 3008(a) Compliance Order	Date:	09/23/1998
Viol. #:	IND006036792S0005	Violation Type:	Generator - Any Requirements		
Eval. #:	19980227005	Agency: State		Evaluation Date:	02/27/1998
Viol. #:	IND006036792S0006	Violation Type:	TSD - Land Ban Requirements		
Eval. #:	19990215006	Agency: State		Evaluation Date:	02/15/1999
Viol. #:	IND006036792S0007	Violation Type:	Generator - Any Requirements		

VIOLATIONS

Viol. #:	IND006036792S0008	Violation Type:	Generator - Any Requirements
Viol. #:	IND006036792S0009	Violation Type:	Generator - Any Requirements
Viol. #:	IND006036792S0010	Violation Type:	Generator - Any Requirements
Viol. #:	IND006036792S0011	Violation Type:	Generator - Any Requirements

RAATS (RCRA Administrative Action Tracking System) Data

No RAATS Information Reported for this Site

RCRA Corrective Action Data (CORRACTS) Instrument and Event Data

No Corrective Action Instrument Information for this Site

Map ID#: 21	Distance (mi): 0.000000	Name:	HOFMANN BODY SHOP		
	Direction: -	Address:	1735 US 27 N		
EPA ID#: IND984876201		City, State, Zip:	LIBERTY	IN	47353
Status: Small Quantity Generator					
Land Type: Unknown		SIC Code:			
Record Date: 06/04/1990		Contact Name:	JACK HOFMANN		
Used Oil Recyc Unverified		Contact Phone:	317-458-5677		

RCRA Evaluation / Violation / Enforcement Data

RCRA TSD and Generators Data

Facility and Compliance Information

No Compliance Information Reported

RAATS (RCRA Administrative Action Tracking System) Data

No RAATS Information Reported for this Site

RCRA Corrective Action Data (CORRACTS) Instrument and Event Data

No Corrective Action Instrument Information for this Site

Map ID#:	27	Distance (mi): 0.000000	Name:	KIRK NATIONALEASE		
		Direction: -	Address:	186 KITCHEL RD		
EPA ID#:	IND981799513		City, State, Zip:	LIBERTY	IN	47353
Status:	Small Quantity Generator					
Land Type:	Unknown		SIC Code:			
Record Date:	02/09/1987		Contact Name:	JEFF GOTTSCHALK		
Used Oil Recyc	Unverified		Contact Phone:	513-498-1151		

RCRA Evaluation / Violation / Enforcement Data

No Compliance Information Reported

RAATS (RCRA Administrative Action Tracking System) Data

No RAATS Information Reported for this Site

RCRA Corrective Action Data (CORRACTS) Instrument and Event Data

No Corrective Action Instrument Information for this Site

RCRA Wastes and Waste Code Information previously reported by EcoSearch have been removed from the RCRIS database by the USEPA.

PCS Data

Permit Compliance System Database (NPDES Data)

Map ID#:	3	Distance (mi):	0.00000		
		Direction:		Name:	LIBERTY MUNICIPAL WWTP
				Address:	SR 44 DEWEY ST
				City, State, Zip:	LIBERTY, IN 47353
Permit Issued:	28-OCT-90	Permit Expired:	28-FEB-95		

Indiana SWF Data

Indiana Solid Waste Facilities Data

Map ID#:	24	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	81-0002			Name:	UNION COUNTY TRANSFER STATION
				Address:	3 MILES NORTHEAST OF LIBERTY ON CR 100 EAST
Facility Type:	County Transfer Station			County:	UNION
Delisted:	No				
Expiration Date:	7/1/00				
				Owner:	UNION CO COMMISSIONERS
Contact:	TERRY CHEWNING			Responsible Part	UNION CO COMM
Phone:	(765 458-6757			Address:	COURTHOUSE
				City, St, Zip:	LIBERTY, IN 47353
				Phone:	765-458-5464

Map ID#:	25	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	81-1			Name:	UNION COUNTY LANDFILL
				Address:	C.R. 100E & C.R. 200N
Facility Type:	Private Landfill			County:	UNION
Delisted:	No				
Expiration Date:	1/1/81				
				Owner:	Not Reported
Contact:	Not Reported			Responsible Part	Not Reported
Phone:	Not Reported			Address:	Not Reported
				City, St, Zip:	Not Reported
				Phone:	Not Reported

Indiana LUST Data

Indiana Leaking Underground Storage Tank Data

Map ID#:	**9B**	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	199602199			Name:	RICHARDSON SUNOCO
				Address:	10 S MAIN ST
Priority:	Medium			City, State Zip:	LIBERTY, IN 47353
Substance:	Not Reported				
				Status:	Active

Media Affected:
- Soil
- Groundwater

Map ID#:	**12B**	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	199403534			Name:	UNION 76 LIBERTY CARTER'S SERVICE
				Address:	101 N MAIN ST
Priority:	Low			City, State Zip:	LIBERTY, IN 47353
Substance:	Not Reported				
				Status:	Discontinued

Media Affected:
- Soil

Map ID#:	**12F**	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	199911531			Name:	UNION 76 LIBERTY CARTER'S SERVICE
				Address:	101 N MAIN ST
Priority:	Low			City, State Zip:	LIBERTY, IN 47353
Substance:					
				Status:	Active

Media Affected:
- Soil

Map ID#:	**16B**	Distance (mi):	0.00000		
		Direction:	-		
Agency ID:	199903564			Name:	UNION COUNTY FARM BUREAU CO-OP
				Address:	101 W CAMPBELL ST
Priority:	Low			City, State Zip:	LIBERTY, IN 47353
Substance:	Not Reported				
				Status:	Active

Media Affected:
- Soil

Indiana UST Data

Indiana Registered Underground Storage Tank Data

Map ID#: 2A
Distance (mi): 0.00000
Direction: -
Agency ID: 20607

Owner: Disputed Ownership
Address: Owner Uncertain
City, State Zip: Indianapolis, IN 46207
Phone: Not Reported

Name: FRAME'S OUTDOOR SPORTS
Address: RR1
City, State Zip: LIBERTY, IN

Tank Id:	Capacity	Status	Installed	Closed
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported

Map ID#: 2B
Distance (mi): 0.00000
Direction: -
Agency ID: 17058

Owner: Frame's Outdoor Sports Supplies
Address: Rr 2 Box 202a
City, State Zip: Liberty, IN 47353
Phone: 317-458-7227

Name: FRAME'S OUTDOOR SPORTS SUPPLIES
Address: RR 2 BOX 202A
City, State Zip: LIBERTY, IN 47353

Tank Id:	Capacity	Status	Installed	Closed
2	1,000.00	Permanently Out of Service	Not Reported	Not Reported
1	1,000.00	Permanently Out of Service	Not Reported	Not Reported

Map ID#: 5A
Distance (mi): 0.00000
Direction: -
Agency ID: 19323

Owner: Union Co National Bank
Address: 107 W Union St
City, State Zip: Liberty, IN 47353
Phone: 317-458-5131

Name: SEE FID 009473
Address: 3 N RAILROAD ST
City, State Zip: LIBERTY, IN 47353

Tank Id:	Capacity	Status	Installed	Closed
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported

Map ID#: 5B
Distance (mi): 0.00000
Direction: -
Agency ID: 9473

Owner: Union Co National Bank
Address: 107 W Union St
City, State Zip: Liberty, IN 47353
Phone: 317-458-5131

Name: LIBERTY OIL CO
Address: 3 N RAILROAD ST
City, State Zip: LIBERTY, IN 47353

Tank Id:	Capacity	Status	Installed	Closed
1	6,000.00	Permanently Out of Service	Not Reported	2/15/87
2	3,000.00	Permanently Out of Service	Not Reported	2/15/87
	6,000.00	Permanently Out of Service	Not Reported	2/15/87
	6,000.00	Permanently Out of Service	Not Reported	2/15/87
5	4,000.00	Permanently Out of Service	Not Reported	2/15/87
	3,000.00	Permanently Out of Service	Not Reported	2/15/87
	6,000.00	Permanently Out of Service	Not Reported	2/15/87
8	5,000.00	Permanently Out of Service	Not Reported	2/15/87
	1,000.00	Permanently Out of Service	Not Reported	2/15/87

Map ID#: 7
Distance (mi): 0.00000
Direction: -
Agency ID: 1121

Owner: BP Amoco Oil Co
Address: 2500 N Tibbs Ave Po Box 22348
City, State Zip: Indianapolis, IN 46222
Phone: 317-923-6830

Name: SS #20268
Address: MAIN & SYCAMORE
City, State Zip: LIBERTY, IN 47353

Tank Id:	Capacity	Status	Installed	Closed
1	6,000.00	Permanently Out of Service	Not Reported	Not Reported

4	1,000.00	Permanently Out of Service	Not Reported	Not Reported
3	6,000.00	Permanently Out of Service	Not Reported	Not Reported
2	6,000.00	Permanently Out of Service	Not Reported	Not Reported

Map ID#: **8**
Distance (mi): 0.00000
Direction: -

Agency ID: 9035

Name: JOHNSON'S SERVICE
Address: 206 N MAIN
City, State Zip: LIBERTY, IN 47353

Owner: Paul E & Lois M Garber
Address: 3081 Winnerline Rd
City, State Zip: Eaton, OH 45320
Phone: 513-456-2692

Tank Id:	Capacity	Status	Installed	Closed
1	4,000.00	Permanently Out of Service	Not Reported	11/1/92
2	3,000.00	Permanently Out of Service	Not Reported	11/1/92
3	3,000.00	Permanently Out of Service	Not Reported	11/1/92

Map ID#: **9C**
Distance (mi): 0.00000
Direction: -

Agency ID: 7412

Name: RICHARDSON SUNOCO
Address: 10 S MAIN ST
City, State Zip: LIBERTY, IN 47353

Owner: Richardson Sunoco
Address: 10 S Main St
City, State Zip: Liberty, IN 47353
Phone: 317-458-8911

Tank Id:	Capacity	Status	Installed	Closed
1	8,000.00	Permanently Out of Service	Not Reported	5/31/95
2	6,000.00	Permanently Out of Service	Not Reported	5/31/95
3	3,000.00	Permanently Out of Service	Not Reported	5/31/95

Map ID#: **10**
Distance (mi): 0.00000
Direction: -

Agency ID: 10991

Name: HERDRICH PETROLEUM LIBERTY SHELL
Address: 10 N MAIN ST
City, State Zip: LIBERTY, IN 47353

Owner: Herdrich Petroleum Corp
Address: 276 N 150 W
City, State Zip: Rushville, IN 46173
Phone: 765-932-3224

Tank Id:	Capacity	Status	Installed	Closed
5	1,000.00	Currently in use	6/1/85	Not Reported
4	8,000.00	Currently in use	6/1/85	Not Reported
3	10,000.00	Currently in use	6/1/85	Not Reported
2	10,000.00	Currently in use	6/1/85	Not Reported
1	10,000.00	Currently in use	6/1/85	Not Reported

Map ID#: **11**
Distance (mi): 0.00000
Direction: -

Agency ID: 16531

Name: SCAGGS OIL CO
Address: 110 N MAIN ST
City, State Zip: LIBERTY, IN 47353

Owner: Harold E Scaggs Oil Co
Address: 110 N Main St
City, State Zip: Liberty, IN 47353
Phone: 317-458-6681

Tank Id:	Capacity	Status	Installed	Closed
4	8,000.00	Currently in use	1/1/89	Not Reported
3	8,000.00	Currently in use	1/1/89	Not Reported
	8,000.00	Currently in use	1/1/89	Not Reported
	8,000.00	Currently in use	1/1/89	Not Reported

Map ID#:	12A	Distance (mi):	0.00000
		Direction:	-
Agency ID:	8959	Name:	UNION 76 LIBERTY CARTER'S SERVICE
		Address:	101 N MAIN ST
Owner:	William R Carter Sr	City, State Zip:	LIBERTY, IN 47353
Address:	381 N Park Hill Dr		
City, State Zip:	Liberty, IN 47353		
Phone:	765-458-5075		

Tank Id:	Capacity	Status	Installed	Closed
7	8,000.00	Currently in use	4/25/94	Not Reported
8	8,000.00	Currently in use	4/25/94	Not Reported
9	8,000.00	Currently in use	4/25/94	Not Reported
1	3,000.00	Permanently Out of Service	Not Reported	3/31/94
2	3,000.00	Permanently Out of Service	Not Reported	3/31/94
3	4,000.00	Permanently Out of Service	Not Reported	3/31/94
4	4,000.00	Permanently Out of Service	Not Reported	3/31/94
5	10,000.00	Permanently Out of Service	7/1/82	11/11/99
6	550.00	Permanently Out of Service	Not Reported	5/8/92

Map ID#:	13	Distance (mi):	0.00000
		Direction:	-
Agency ID:	11055	Name:	MILES-RICHMOND INC
		Address:	221 S MAIN ST
Owner:	Miles-Richmond Inc	City, State Zip:	LIBERTY, IN 47353
Address:	221 S Main St		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-5111		

Tank Id:	Capacity	Status	Installed	Closed
1	10,000.00	Permanently Out of Service	Not Reported	Not Reported

Map ID#:	16A	Distance (mi):	0.00000
		Direction:	-
Agency ID:	6923	Name:	UNION COUNTY FARM BUREAU CO-OP
		Address:	101 W CAMPBELL ST
Owner:	Union County Farm Bureau Co-Op	City, State Zip:	LIBERTY, IN 47353
Address:	Po Box 70		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-5141		

Tank Id:	Capacity	Status	Installed	Closed
11	20,000.00	Currently in use	2/12/98	Not Reported
10	20,000.00	Currently in use	2/12/98	Not Reported
9	10,000.00	Currently in use	2/12/98	Not Reported
8	10,000.00	Currently in use	2/12/98	Not Reported
7	10,000.00	Currently in use	2/12/98	Not Reported
6	10,000.00	Currently in use	2/12/98	Not Reported
5	10,000.00	Currently in use	2/12/98	Not Reported
4	10,000.00	Currently in use	2/12/98	Not Reported
1	10,000.00	Permanently Out of Service	4/5/79	2/10/98
2	10,000.00	Permanently Out of Service	4/5/79	2/10/98
3	1,000.00	Permanently Out of Service	4/5/79	2/1/98

Map ID#:	19	Distance (mi):	0.00000
		Direction:	-
Agency ID:	22353	Name:	UNION COUNTY EMT
		Address:	SR 27
Owner:	Union County Commissioners	City, State Zip:	LIBERTY, IN 47353
Address:	26 W Union St		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-5464		

Tank Id:	Capacity	Status	Installed	Closed
3	8,000.00	Permanently Out of Service	1/1/91	11/1/98
	4,000.00	Permanently Out of Service	1/1/90	11/1/98
1	4,000.00	Permanently Out of Service	1/1/90	11/1/98

Indiana UST Data

Indiana Registered Underground Storage Tank Data

Map ID#:	20	Distance (mi):	0.00000
		Direction:	-
Agency ID:	5323	Name:	TOWN GARAGE
		Address:	RR 3
		City, State Zip:	LIBERTY, IN 47353
Owner:	Town Of Liberty		
Address:	1 S Fairground St Po Box 7		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-5823		

Tank Id:	Capacity	Status	Installed	Closed
1	7,000.00	Permanently Out of Service	Not Reported	Not Reported

Map ID#:	22	Distance (mi):	0.00000
		Direction:	-
Agency ID:	11693	Name:	UNION COUNTY SCHOOL CORP
		Address:	107 LAYMAN ST
		City, State Zip:	LIBERTY, IN 47353
Owner:	Union County School Corp		
Address:	107 Layman St		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-5783		

Tank Id:	Capacity	Status	Installed	Closed
1	500.00	Permanently Out of Service	Not Reported	8/1/91

Map ID#:	26	Distance (mi):	0.00000
		Direction:	-
Agency ID:	3346	Name:	HAROLD CROUSE & SONS
		Address:	RR 3 BOX 58
		City, State Zip:	LIBERTY, IN 47353
Owner:	Harold Crouse & Sons		
Address:	43 Box 58		
City, State Zip:	Liberty, IN 47353		
Phone:	317-458-6208		

Tank Id:	Capacity	Status	Installed	Closed
1	6,000.00	Permanently Out of Service	Not Reported	5/10/98
2	1,000.00	Unregulated	9/9/92	Not Reported

Indiana SPILL Data

Indiana Spills Data

Map ID#:	1	Distance (mi):	0.00000	Responsible Party:	UNKNOWN
		Direction:	-	Reported Address:	1 MI W OF LIBERTY N OF 44
Agency ID:	9105052			City, Zip:	Liberty 47353
Incident Date:	5/8/91	Incident Type:	Fish Kill	Circumstances:	Unknown
Reported Date:	5/8/91	Area Affected:	300 Ft Shorelin		
				Fish Killed:	100.00
Reported By:	Private Citizen			Water Supply Affected:	Undefined
Investigated By:	ERS Staff			Waterway Affected:	Richland Creek
Spill Source:	Unknown				
Enforcement Actio	None			Environmental Consequences:	Fish Kill
Action Taken:	None				

Spill Material:	Fish Kill	Amount Recovered:	0 Gallons
Spill Amount:	0 Gallons	Cleanup Duration:	None
		Contained:	No

Map ID#:	4A	Distance (mi):	0.00000	Responsible Party:	D AND L INDUSTRIAL FINISHES
		Direction:	-	Reported Address:	215 BROWNSVILLE AVE
Agency ID:	9903176			City, Zip:	Liberty 47353
Incident Date:	3/29/99	Incident Type:	Other	Circumstances:	Equipment Failure
Reported Date:	3/29/99	Area Affected:	Secondary Containment		
				Fish Killed:	0.00
Reported By:	Private Citizen			Water Supply Affected:	No
Investigated By:	ERS Staff			Waterway Affected:	None
Spill Source:	Industrial				
Enforcement Actio	Referred To Other Area			Environmental Consequences:	Minimal - Log Only
Action Taken:	On-going				

Spill Material:	Textile Spirits	Amount Recovered:	Not Reported
Spill Amount:	5 Gallons	Cleanup Duration:	Ongoing
		Contained:	Yes

Spill Material:	Rainwater In 2nd Contain	Amount Recovered:	Not Reported
Spill Amount:	1000 Gallons	Cleanup Duration:	Ongoing
		Contained:	Yes

Map ID#:	6	Distance (mi):	0.00000	Responsible Party:	HAROLD SCAGGS
		Direction:	-	Reported Address:	NORTH MAIN & BROWNSVILLE RD
Agency ID:	8905123			City, Zip:	Liberty 47353
Incident Date:	5/26/89	Incident Type:	Hazardous	Circumstances:	Miscellaneous
Reported Date:	5/26/89	Area Affected:	Unknown		
				Fish Killed:	0.00
Reported By:	Private Citizen			Water Supply Affected:	No
Investigated By:	ERS Staff			Waterway Affected:	Ditch
Spill Source:	Leaking Undergrou				
Enforcement Actio	None			Environmental Consequences:	No Water Qual. Violation
Action Taken:	Cleaned Up				

Spill Material:	Gasoline/Water	Amount Recovered:	0 Gallons
Spill Amount:	0 Gallons	Cleanup Duration:	1 Day
		Contained:	No

Indiana SPILL Data

Indiana Spills Data

Map ID#: 9A
Distance (mi): 0.00000
Direction: -
Agency ID: 9602199
Responsible Party: TIM WOODRUFF
Reported Address: 10 S MAIN ST
City, Zip: Liberty 47353

Incident Date: 2/28/96
Reported Date: 2/29/96
Incident Type: Air
Area Affected: Undetermined
Circumstances: Miscellaneous

Reported By: State Government Agency
Investigated By: ERS - Field Response
Spill Source: Commercial
Enforcement Actio Referred To Other Area
Action Taken: Partially Cleaned Up

Fish Killed: No
Water Supply Affected: None
Waterway Affected:
Environmental Consequences: Undetermined

Spill Material: Solid Waste
Spill Amount: Unknown
Amount Recovered: Not Reported
Cleanup Duration: Not Reported
Contained: No

Spill Material: Open Burn
Spill Amount: Unknown
Amount Recovered: Not Reported
Cleanup Duration: Not Reported
Contained: No

Spill Material: Unknown-55 Gallon Drums
Spill Amount: Unknown
Amount Recovered: Not Reported
Cleanup Duration: Not Reported
Contained: Yes

Map ID#: 12C
Distance (mi): 0.00000
Direction: -
Agency ID: 9906166
Responsible Party: KIEL BROS. OIL CO.
Reported Address: 101 N MAIN ST
City, Zip: Liberty 47353

Incident Date: 6/16/99
Reported Date: 6/16/99
Incident Type: Spill
Area Affected: Undertermined
Circumstances: Miscellaneous

Reported By: Responsible Party (RP)
Investigated By: ERS Staff
Spill Source: Commercial
Enforcement Actio None
Action Taken: Cleaned Up

Fish Killed: 0.00
Water Supply Affected: Undefined
Waterway Affected: None
Environmental Consequences: Minimal - Log Only

Spill Material: Not Reported
Spill Amount: Not Reported
Amount Recovered: Not Reported
Cleanup Duration: Not Reported
Contained: No

Map ID#: 12E
Distance (mi): 0.00000
Direction: -
Agency ID: 9810115
Responsible Party: B & C ONE STOP & SHOP
Reported Address: 101 N MAIN ST
City, Zip: Liberty 47353

Incident Date: 10/13/98
Reported Date: 10/13/98
Incident Type: Spill
Area Affected: 360 Sq Ft
Circumstances: Miscellaneous

Reported By: Law Enforcement Agency
Investigated By: Other
Spill Source: Commercial
Enforcement Actio None
Action Taken: Cleaned Up

Fish Killed: No
Water Supply Affected: Storm Sewer
Waterway Affected:
Environmental Consequences: No Water Qual. Violation

Spill Material: Diesel Fuel
Spill Amount: 150 Gallons
Amount Recovered: Not Reported
Cleanup Duration: Not Reported
Contained: Yes

Indiana SPILL Data

Indiana Spills Data

Map ID#:	17	Distance (mi):	0.00000	Responsible Party:	GTE
		Direction:	-	Reported Address:	4 E WESTCOTT
Agency ID:	9307112			City, Zip:	Liberty 47353
Incident Date:	7/13/93	Incident Type:	Spill	Circumstances:	Equipment Failure
Reported Date:	7/13/93	Area Affected:	169 Sq Ft	Fish Killed:	0.00
Reported By:	Other			Water Supply Affected:	Undefined
Investigated By:	ERS Staff			Waterway Affected:	None
Spill Source:	Other				
Enforcement Actio	None			Environmental Consequences:	Undetermined
Action Taken:	Voluntary Remediatio				
Spill Material:	Heating Oil Lust			Amount Recovered:	0 Gallons
Spill Amount:	0 Gallons			Cleanup Duration:	Ongoing
				Contained:	No

Map ID#:	23	Distance (mi):	0.00000	Responsible Party:	UNION COUNTY HIGH SCHOOL
		Direction:	-	Reported Address:	HIGHSCHOOL SCIENCE STORAGE
Agency ID:	9310180			City, Zip:	Liberty 47353
Incident Date:	Not Reported	Incident Type:	Hazardous	Circumstances:	Miscellaneous
Reported Date:	10/25/93	Area Affected:	Unknown	Fish Killed:	0.00
Reported By:	County Health Department			Water Supply Affected:	No
Investigated By:	County Health Department			Waterway Affected:	None
Spill Source:	Municipal STP				
Enforcement Actio	Referred To Other Area			Environmental Consequences:	Minimal - Log Only
Action Taken:	On-going				
Spill Material:	Misc Lab Chemicals			Amount Recovered:	0 Gallons
Spill Amount:	0 Gallons			Cleanup Duration:	Ongoing
				Contained:	Yes

Indiana Union County SPILL Data

Indiana Union County Spills Data

Map ID#:	12D	Distance (mi):	0.00000		
Agency ID:	1999-1	Direction:	-	Reported Address:	101 N. Main St.
				City, Zip:	Liberty IN,47353
Reported Date:	06/16/99				
				Medium Affected:	Not Reported
				Name of Affected Medium:	Concrete drive (3,000 sq. ft.)
injuries:	0			Spill Source:	UST
Deaths:	0			Cause of Release:	equipment failure
Evacuations:	0			Release Description:	during filling of UST from tanker truck, gasoline discharged from tank due to faulty vent line
				Material(s) Spilled:	gasoline
Property Damage	0			Quantity Spilled	50 gal.
				Quantity in Water:	0

Action Taken: contained and cleaned up

Map ID#:	14	Distance (mi):	0.00000		
Agency ID:	Not Reported	Direction:	-	Reported Address:	217 S. Main St.
				City, Zip:	Liberty IN,47353
Reported Date:	12/02/99				
				Medium Affected:	soil
				Name of Affected Medium:	
injuries:	0			Spill Source:	UST
Deaths:	0			Cause of Release:	LUST
Evacuations:	0			Release Description:	Liquid Sorghum leaked from storage tank, seaped to surface
				Material(s) Spilled:	Liquid Sorghum (Molasses)
Property Damage	0			Quantity Spilled	unk.
				Quantity in Water:	0

Action Taken: contained and cleaned up, impacted soil excavated

Map ID#:	15	Distance (mi):	0.00000		
Agency ID:	3001	Direction:	-	Reported Address:	SR 27 and Hwy 44
				City, Zip:	Liberty IN,47353
Reported Date:	03/01/200				
				Medium Affected:	Not Reported
				Name of Affected Medium:	Roadway
injuries:	0			Spill Source:	semi truck
Deaths:	0			Cause of Release:	equipment failure
Evacuations:	0			Release Description:	diesel fuel leaked from a semi truck fuel tank
				Material(s) Spilled:	diesel
Property Damage	0			Quantity Spilled	100 gal.
				Quantity in Water:	0

Action Taken: contained and cleaned up, impacted material disposed

Indiana Union County SPILL Data

Indiana Union County Spills Data

Map ID#:	18	Distance (mi):	0.00000		
		Direction:	-	Reported Address:	N. Fairground & Campbell
Agency ID:	990092			City, Zip:	Liberty IN,47353
Reported Date:	11/24/99				
				Medium Affected:	Not Reported
				Name of Affected Medium:	Roadway
injuries:	0			Spill Source:	container
Deaths:	0			Cause of Release:	spill
				Release Description:	gasoline can dropped from back of vehicle
Evacuations:	0			Material(s) Spilled:	gasoline
Property Damage	0			Quantity Spilled	2 gal.
				Quantity in Water:	0

Action Taken: none

Unmappable Sites

A limitation of many records of governmental databases is incomplete or incorrect address information. Without proper addresses, it is more difficult to locate and map these sites.

Instead of leaving these potentially important sites out of the EcoSearch report, we implement a painstaking manual geocoding strategy aimed at plotting these unmappable sites by looking at zip codes, city names, and county names identified with the radius around your study site. The zip codes, cities, and counties searched are identified on the EcoSearch Statistical Overview page.

Our sophisticated mapping software, enhanced TIGER street maps, and address correction database processing methods find and plot most environmental sites. We then perform manual geocoding, plotting those sites the computer fails to find using a variety of resources. These include using our in-house collection of paper maps, directories, cross-referencing database information, and calling post offices, local government, or the sites themselves to accurately locate environmental records. We also correct obvious TIGER street map errors and omissions.

This effort at manual geocoding results in a short or non-existant orphan/unmappable list and increases accuracy and reliability of the data in our reports. We have elected not to computerize this part of our report due to the importance of presenting all data as completely and accurately as humanly possible. When this function is computerized it is impossible to produce a report as accurate as one where manual geocoding has taken place.

The limited number of sites which could not be reasonably found through our geocoding strategy are presented in this section for further review to assess their impact on your study site.

After the summary unmappable site information, detailed data follows.

Unmappable Sites

Database	Agency ID#	Site Name and Address	County
LUST Indiana Leaking Underground Storage Tank	199303514	SEE FAC ID 10339 RR 2 LIBERTY, IN 47353-9802	UNION
UST Indiana Underground Storage Tank	18246	SEE FAC ID 10339 RR 2 LIBERTY, IN 47353-9802	UNION

Indiana LUST Data

Indiana Leaking Underground Storage Tank Data

Map ID#:	1UN	Distance (mi):	0.00000		
		Direction:			
Agency ID:	199303514			Name:	SEE FAC ID 10339
				Address:	RR 2
Priority:	Low			City, State Zip:	LIBERTY, IN 47353
Substance:	Not Reported				
				Status:	No Further Action

Media Affected:
Soil

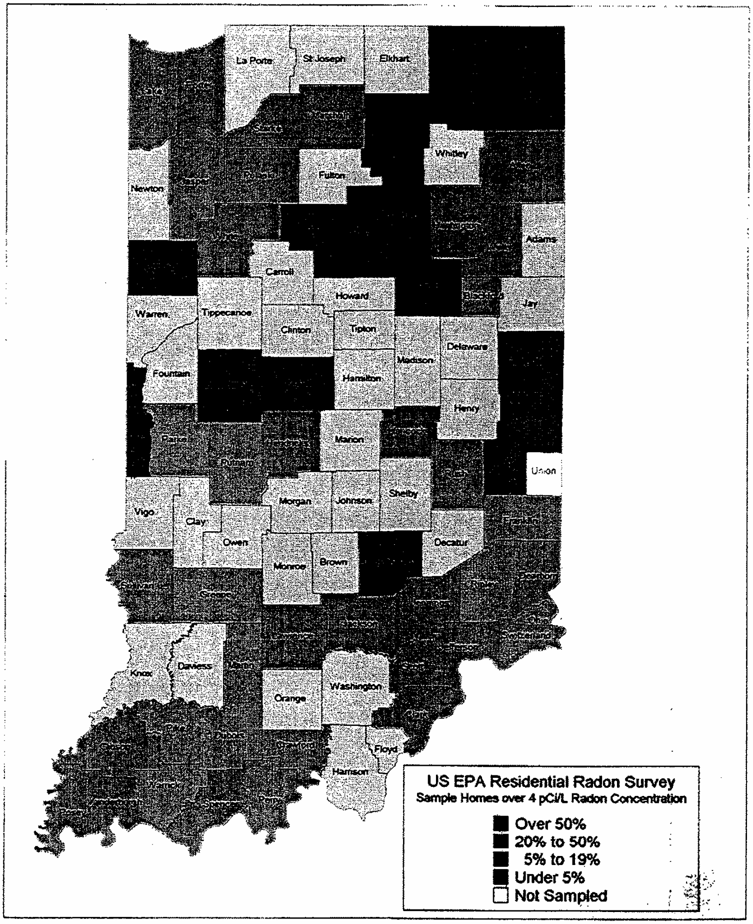
Indiana UST Data

Indiana Registered Underground Storage Tank Data

Map ID#:	2UN	Distance (mi):	0.00000		
		Direction:			
Agency ID:	18246			Name:	SEE FAC ID 10339
				Address:	RR 2
Owner:	Disputed Ownership			City, State Zip:	LIBERTY, IN 47353
Address:	Owner Uncertain				
City, State Zip:	Indianapolis, IN 46207				
Phone:	Not Reported				

Tank Id:	Capacity	Status	Installed	Closed
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported
Not Reported	Not Reported	Not Reported	Not Reported	Not Reported

EcoSearch Radon Risk Map for Indiana



SOURCE: EPA Map for Radon Zones (Indiana), September 1993. The data is based on the The data is based on the State/EPA Residential Radon Survey which was conducted in Indiana during the winters of 1987-88. This map shows the percentage of homes in each county registering over 4 pCi/L (picocuries per liter) radon concentration. For additional information on this survey, consult the next page.

Note: The information provided on this map is subject to the disclaimer on the first page. This map is NOT intended to determine if a property in a given county should be tested for radon.

Properties with elevated levels of radon have been found in all counties.

If or when radon is a concern, all properties should be tested regardless of the county designation.

EPA Residential Radon Survey for Indiana

County	Sample Size	Homes over 4pCi/L Number	Homes over 4pCi/L Percentage	Homes over 20pCi/L Number	Homes over 20pCi/L Percentage
Adams	14	5	35.71%	0	0.00%
Allen	169	29	17.16%	2	1.18%
Bartholomew	28	16	57.14%	0	0.00%
Benton	2	1	50.00%	0	0.00%
Blackford	4	0	0.00%	0	0.00%
Boone	9	5	55.56%	0	0.00%
Brown	3	1	33.33%	0	0.00%
Carroll	7	2	28.57%	0	0.00%
Cass	6	3	50.00%	0	0.00%
Clark	92	17	18.48%	1	1.09%
Clay	8	2	25.00%	0	0.00%
Clinton	7	2	28.57%	0	0.00%
Crawford	2	0	0.00%	0	0.00%
Daviess	5	1	20.00%	0	0.00%
De Kalb	21	12	57.14%	0	0.00%
Dearborn	6	1	16.67%	0	0.00%
Decatur	5	1	20.00%	0	0.00%
Delaware	16	4	25.00%	0	0.00%
Dubois	5	0	0.00%	0	0.00%
Elkhart	76	31	40.79%	0	0.00%
Fayette	6	3	50.00%	0	0.00%
Floyd	32	8	25.00%	0	0.00%
Fountain	13	6	46.15%	3	23.08%
Franklin	4	0	0.00%	0	0.00%
Fulton	9	2	22.22%	0	0.00%
Gibson	16	2	12.50%	0	0.00%
Grant	13	7	53.85%	1	7.69%
Greene	16	0	0.00%	0	0.00%
Hamilton	23	6	26.09%	0	0.00%
Hancock	8	1	12.50%	0	0.00%
Harrison	19	8	42.11%	2	10.53%
Hendricks	22	3	13.64%	0	0.00%
Henry	11	3	27.27%	0	0.00%
Howard	22	7	31.82%	0	0.00%
Huntington	13	1	7.69%	0	0.00%
Jackson	7	1	14.29%	0	0.00%
Jasper	11	0	0.00%	0	0.00%
Jay	5	2	40.00%	0	0.00%
Jefferson	16	3	18.75%	0	0.00%
Jennings	19	2	10.53%	0	0.00%
Johnson	34	10	29.41%	0	0.00%
Knox	9	4	44.44%	0	0.00%
Kosciusko	30	18	60.00%	1	3.33%
La Porte	66	21	31.82%	2	3.03%
Lagrange	9	5	55.56%	1	11.11%
Lake	125	3	2.40%	0	0.00%
Lawrence	28	5	17.86%	1	3.57%
Madison	27	10	37.04%	0	0.00%
Marion	115	43	37.39%	3	2.61%
Marshall	3	0	0.00%	0	0.00%
Martin	5	0	0.00%	0	0.00%
Miami	28	15	53.57%	1	3.57%
Monroe	30	9	30.00%	1	3.33%
Montgomery	21	11	52.38%	0	0.00%
Morgan	7	3	42.86%	0	0.00%
Newton	12	4	33.33%	0	0.00%
Noble	20	10	50.00%	0	0.00%
Ohio	4	0	0.00%	0	0.00%
Orange	11	4	36.36%	1	9.09%
Owen	5	1	20.00%	0	0.00%
Parke	7	0	0.00%	0	0.00%
Perry	3	0	0.00%	0	0.00%
Pike	8	0	0.00%	0	0.00%
Porter	84	16	19.05%	0	0.00%
Posey	6	1	16.67%	0	0.00%
Pulaski	5	0	0.00%	0	0.00%
Putnam	6	0	0.00%	0	0.00%
Randolph	9	5	55.56%	0	0.00%
Ripley	6	0	0.00%	0	0.00%
Rush	1	0	0.00%	0	0.00%
Scott	21	2	9.52%	0	0.00%
Shelby	7	3	42.86%	0	0.00%
Spencer	11	1	9.09%	0	0.00%
St Joseph	114	30	26.32%	2	1.75%
Starke	8	0	0.00%	0	0.00%
Steuben	13	9	69.23%	0	0.00%
Sullivan	12	1	8.33%	0	0.00%
Switzerland	2	0	0.00%	0	0.00%
Tippecanoe	39	19	48.72%	2	5.13%
Tipton	5	1	20.00%	0	0.00%
Union	0	0	0.00%	0	0.00%
Vanderburgh	32	6	18.75%	0	0.00%
Vermillion	8	4	50.00%	1	12.50%
Vigo	34	15	44.12%	1	2.94%
Wabash	15	9	60.00%	0	0.00%
Warren	4	1	25.00%	1	25.00%
Warrick	21	1	4.76%	0	0.00%
Washington	10	3	30.00%	0	0.00%
Wayne	18	12	66.67%	1	5.56%
Wells	7	1	14.29%	0	0.00%
White	16	2	12.50%	0	0.00%
Whitley	23	10	43.48%	0	0.00%

SOURCE: EPA Map of Radon Zones: Indiana (September 1993)

This EPA/State survey was conducted in Indiana during the winters of 1986-88. Over 1,989 homes were tested with short-term (2-7 day) charcoal canisters placed in the lowest livable area of the home. These tests determine the radon concentration, measured in pCi/L (picocuries per liter). The average radon concentration measurement in the U.S. is between 1 and 2 pCi/L. The EPA has established the guideline of 4 pCi/L as an "elevated" indoor radon level.

NOTE: The sample size in each county may not be sufficient to show statistical significance. This information is NOT intended to determine if a property in a given county should be tested for radon. If or when radon is a concern, all properties should be tested regardless of the county statistics.

Environmental Glossary

Acid

A large class of substances having a pH less than seven. An acid waste is considered hazardous when the pH is 2.0 or less.

Acute Effect

An adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis.

Acute Exposure

A dose that is delivered to the body in a single event or in a short period of time.

Aerobic

Occurring in the presence of free oxygen.

Alkaline

A substance with a pH between 7 and 14. An alkaline waste is considered hazardous when its pH is 12.5 or greater.

Ambient

Existing conditins of air, water, and other media at a particular time.

Anaerobic

Occurring in the absence of oxygen.

Assessment

Background Environmental Sample

Samples that are considered to contain no contaminants or known concentrations of contaminants.

Base

A substance which forms a salt when reacted with an acid. Bases have a pH of greater than seven.

Buffer Zone

An area of land which surrounds a hazardous waste facility and on which certain land uses and activities are restricted to protect the public health and safety and the environment from existing or potential hazards caused by the migration of hazardous waste (CH&SC Sec. 25110.3).

Carcinogen

A substance or agent capable of causing or producing cancer in mammals.

Caustics

A large class of substances which form solutions having a high pH.

Chronic Effect

An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which reoccur frequently.

Chronic Exposure

Low doses repeatedly received by the body over a long period of time.

Combustible

A term used by the NFPA, DOT, and others to classify certain liquids that will burn, on the basis of flash points. Both the NFPA and DOT generally define "combustible liquids" as having a flash point of 100° F or higher.

Concentration

The relative amount of a substance when combined or mixed with other substances.

Contingency Plan

A document setting out an organized, planned, and coordinated course of action to be followed in case of a fire or explosion or release of a hazardous waste from a TSD or a generator's facility that could threaten human health or the environment (RCRA).

Corrosive

As defined by DOT, a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or in the case of leakage from its packaging a liquid that has a severe corrosion rate on steel. A solid or liquid which exhibits these characteristics can be regulated as hazardous waste.

Decomposition

Breakdown of material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into elements or simpler compounds.

Decontamination

The process of removing contaminants from individuals and equipment.

Deep Well Injection

Disposal of wastes by injecting them into a geological formation deep in the ground, sometimes after pretreatment to avoid solidification.

EPA ID Number

This unique number assigned by EPA to each generator, transporter, or TSD.

Effluent

Waste material, either treated or untreated, discharged into the environment.

Environmental Assessment

The measurement or prediction of the transport, dispersion, and final location of a hazardous substance when released into the environment.

Environmental Emergencies

Incidents involving the release (or potential release) of hazardous materials into the environment which require immediate remedial action.

Environmental Hazard

A condition capable of posing risk of exposure to air, water, soil, plants, or wildlife.

Exception Report

A report that generators who transport waste off-site must submit if they do not receive a properly completed copy of their manifest within 45 days of the date on which the initial transporter accepted the waste.

Generator

The person or facility who, by nature or ownership, management or control, is responsible for causing or allowing to be caused, the creation of hazardous waste.

Glovebag

A device used to remove a section of pipe insulation without isolating the entire space or room.

Groundwater Hydrology

The study of the movement of water below the earth's surface.

Hazard

A circumstance or condition that can cause harm. Hazards are often categorized into four groups: biological, chemical, physical, and radiation.

Hazard Classes

A series of nine descriptive terms that have been established by the UN Committee of Experts to categorize the hazardous nature of chemical, physical, and biological materials. These categories are: flammable liquids, explosives, gases, oxidizers, radioactive materials, corrosives, flammable solids, poisonous and infectious substances, and dangerous substances.

Hazardous Waste

Any material that is subject to the hazardous waste manifest requirements of the EPA specified in the CFR, Title 40, Part 262 or would be subject to these requirements in the absence of an interim authorization to a State under CFR, Title 40, Part 123, Subpart F.

Heavy Metals

Certain metallic elements having a high density and generally toxic, e.g., lead, silver, mercury, and arsenic.

Immediate Removal

Actions undertaken to prevent or mitigate immediate and significant risk of harm to human life or health or the environment. As set forth in the National Contingency Plan, these actions shall be terminated after $1 million has been obligated or six months have elapsed from the date of initial response.

Incident

The release or potential release of a hazardous substance into the environment.

Inert

Exhibiting no chemical activity; totally unreactive.

Innocent Land Owner's Defense

The defense of a purchaser of real property that he or she exercised due diligence in having hazards assessed prior to purchase.

Interim Status

Allows owners and operators of TSDs that were in existence, or for which construction had commenced, prior to November 19, 1980 to continue to operate without a permit after this date pending final issuance from RCRA.

Joint and Several Liability

Under federal law each party that contributed to damages may be held liable for all damages, but each has the right to compel the others to contribute and indemnify.

Liability

Being subject to legal action for one's behavior.

MSDS Material Safety Data Sheet

Required by OSHA of owners to alert employees to hazards, their effect, and protective action.

Manifest

Form which indicates generator, quantity, and type of waste for each shipment of hazardous wastes disposed in off-site facilities.

National Contingency Plan

Policies and procedures that the Federal Government follows in implementing responses to incidents involving hazardous substances.

P Wastes

A federal waste list comprised of substances categorized as acutely hazardous.

Part A

The first part of a two part application that must be submitted by a TSD to receive a permit. It contains general facility information.

Part B

The second part of a two part application that must be submitted by a TSD to receive a permit. It contains highly technical and detailed information.

Planned Removal

The removal of released hazardous substances from the environment within a non-immediate, long term time period. Under CERCLA: Actions intended to minimize increases in exposure such that time and cost commitments are limited to six months and/or $1 million.

Poison, Class A

A DOT term for extremely dangerous poisons, that is, poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. Some examples: phosgene, cyanogen, and hydrocyanic acid.

Poison, Class B

A DOT term for liquid, solid, paste, or semisolid substances, other than Class A poisons, which are known to be toxic to man as to afford a hazard to health during transportation.

Pollutant

A substance or mixture which after release into the environment and upon exposure to any organisms will or may reasonably be anticipated to cause adverse effects in such organisms and their offspring.

Priority Pollutants

A list of chemicals selected from the list of toxic pollutants by the EPA as priority toxic pollutants for regulation under the Clean Water Act.

Remedial Actions

Responses to releases of hazardous substances on the NPL that are consistent with a permanent remedy which would prevent or mitigate the migration of materials into the environment.

Risk

The probability that an unwanted event will occur.

Second Responders

Those personnel required to assist or relieve first responders at a hazardous material incident due to their specialized knowledge, equipment, or experience. These include State environmental protection or health officials, commercial response, cleanup companies, and appropriate industry representatives.

Strict Liability

Holds a party responsible for damages irrespective of the amount of care taken in handling a hazardous substance.

Subtitle C

The part of RCRA which pertains to the management of hazardous waste.

Subtitle I

The part of RCRA which pertains to the storage of petroleum products and hazardous substances, other than wastes, in USTs.

Superfund

See CERCLA.

Synergistic

The action of two materials together which is greater in effect than the sum of the individuals actions.

TIGER Files

The US Census Bureau's TIGER files provide a nationwide computerized map with address range information.

Tort

A legal wrong, sometimes referred to as negligence.

Toxicity

The ability of a substance to produce injury by non-mechanical means once it reaches a susceptible site in or on the body.

U Wastes

A federal list of hazardous wastes which consists of substances deemed to be hazardous for hazards other than acute hazards.

– Adapted from Lincoln Graduate Center, 1993. Real Estate Environmental Screening. San Antonio, Texas.

Acronyms and Abbreviations

-AIRS	Aerometric Information Retrieval System
-AST	Aboveground Storage Tank
-ASTM	American Society for Testing and Materials
-BLM	Bureau of Land Management
-BNA	Bureau of National Affairs
-CAA	Clean Air Act
-CDC	Centers for Disease Control
-CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
-CERCLIS	CERCLA Information System
-CICIS	Chemicals in Commerce Information System
-COE	U.S. Army Corps of Engineers
-CWA	Clean Water Act
-DDT	Dicholoro-diphenyl-dichloroethane
-DOC	Department of Commerce
-DOCKET	Enforcement Docket System--Office of Enforcement and Compliance Monitoring
-DOE	Department of Energy
-DOT	Department of Transportation
-EPA	Environmental Protection Agency
-ERCS	Emergency Response Cleanup Services
-ERNS	Emergency Response Notification System
-ESA	Environmental Site Assessment
-FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
-FINDS	Facility Index System
-FOIA	Freedom of Information Act
-FWPCA	Federal Water Pollution Control Act
-HHS	Department of Health and Human Services
-HSWA	Hazardous and Solid Waste Amendments of 1984
-HUD	Department of Housing and Urban Development
-LUST	Leaking Underground Storage Tank
-MSDS	Material Safety Data Sheet
-NEPA	National Environment Policy Act
-NESHAP	National Emission Standards for Hazardous Air Pollutants
-NFRAP	No Further Remedial Action Planned (Delisted CERCLA Site)
-NOI	Notice of Intent
-NOV	Notice of Violation
-NPDES	National Pollution Discharge Elimination System
-NPL	National Priorities List
-NRC	Nuclear Regulatory Commission
-NRIS	Nuclear Regulatory Information System
-OSHA	Occupational Safety and Health Administration

Acronyms and Abbreviations

-PADS	PCB Activity Database System
-PCB	Polychlorinated Biphenyls
-POTW	Publicly-Owned Treatment Works
-PPM	Parts Per Million
-PRP	Potentially Responsible Parties
-RAATS	RCRA Administrative Action Tracking System
-RCRA	Resource Conservation and Recovery Act of 1976
-RCRIS	Resource Conservation and Recovery Information System
-RFA	RCRA Facility Assessment
-RFI	RCRA Facility Investigation
-RI	Remedial Investigation (CERCLA)
-SARA	Superfund Amendments and Reauthorization Act of 1986
-SCS	Soil Conservation Service
-SDWA	Safe Drinking Water Act
-SETS	Superfund Enforcement Tracking System
-SSTS	Section Seven Tracking System
-SWF/LF	Solid Waste Facilities / Landfills
-TIGER	Topologically Integrated Geographic Encoding and Referencing System
-TRI	Toxic Release Inventory
-TSCA	Toxic Substances Control Act
-TSD	Treatment, Storage, or Disposal Facility
-USDA	U.S. Department of Agriculture
-USGS	U.S. Geological Survey
-UST	Underground Storage Tank
-WWTP	Wastewater Treatment Plant

APPENDIX H

IDNR Permission Letters for Macroinvertebrate Sampling

Frank O'Bannon, Govern
Larry D. Macklin, Directo

DNR Indiana Department of Natural Resources

RECD MAY 22 2001

Date: 14 May, 2001

Name: Jason C. Hignite
Address: Sagamore Environmental Services
City, State Zip: 8002 Castleway Drive, Suite 104, Indianapolis, IN 46250

THIS PERMIT EXPIRES DECEMBER 31, 2001

This is your authorization to research/collect ***Macroinvertebrates***
Whitewater State Park according to the following conditions:

1. All responsibility for personal injury or damage to any state property which may occur will be assumed directly by you.
2. You are exempt from paying the entrance gate fee when exercising the use of this permit. No other fee waiver or uses are authorized by this permit and conditions of this permit.
3. The collecting will be done at times, if possible, where such collecting cannot be observed by other park visitors. The permit **does not** authorize collecting from the nature preserves located within the Indiana State Parks.
4. Before going to the park, it is your responsibility to write or call the property manager to be sure that an authorized representative will be available to meet with you upon your arrival to the property before your study is commenced.
5. No specimen of flora, fauna, water, mineral or artifact may be disturbed or removed from the properties, except as authorized herein.
6. The Division of State Parks & Reservoirs is to receive a complete report which lists in detail the results of your study. If this information is used in any published report, a copy must be sent to the Division of State Parks & Reservoirs office upon publication.
7. This letter of authorization must be carried with you at all times for the purpose stated in this permit and may not be reproduced by any means.
8. The authority for this permit may be terminated at any time at the discretion of this office.
9. Being aware of the nature and potential hazards of your activity, you do hereby release and hold harmless the State of Indiana, its officers, agents and employees from any and all liability for death, injury or loss or damage to property incurred in connection with the use of this permit.
10. Special Conditions: Study to take place in Silver Creek within the boundaries of Whitewater State Park. Only specimens needed for identification are to be collected.

It is understood that you will exercise extreme care in the use of this permit in order to preserve the existing flora, fauna, artifact, water or mineral found within the state parks.

Gerald Pagac

Gerald J. Pagac, Director
Division of State Parks & Reservoirs
402 W. Washington St., Rm. W298
Indianapolis, IN 46204

GJP/jag
701-242
cc:

An Equal Opportunity Employer
Printed on Recycled Paper

Frank O'Bannon, Gove
Larry D. Macklin, Direct

DNR Indiana Department of Natural Resources

Jason Hignite,

This letter is a written verification of the verbal approval given in June 2001 by Robert Felix, property manager, to Jason Hignite, Sagamore Environmental, to collect maroinvertibrates on the Brookville Reservoir property within the Hanna Creek watershed.

Vernon Gillum
Assistant Manager

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APPENDIX I

Laboratory Report: High Flow

HOOSIER MICROBIOLOGICAL

HML

LABORATORY

Testing • Research • Consulting

Sample: 52822

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#1
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 10:06 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	0.3 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	27 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.1 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	05/25/2001
Phosphate, Ortho-EPA365.2	0.3 mg/L	0.1 mg/L	05/21/2001
Phosphate-365.2	0.4 mg/L	0.3 mg/L	05/22/2001
Turbidity-EPA180.1	70 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	7,000 cfu/100 ml	10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely

Donald A. Hendrickson skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

LABORATORY

Testing • Research • Consulting

Sample: 52823

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#2
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM, 05/18/2001, and collected at 10:18 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	1.9 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	26 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.2 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.3 mg/L	0.1 mg/L	05/25/2001
Phosphate-365.2	0.6 mg/L	0.3 mg/L	05/21/2001
Phosphate, Ortho-EPA365.2	0.6 mg/L	0.1 mg/L	05/22/2001
Turbidity-EPA180.1	47 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	10,000 cfu/100 mL	10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely,

Donald A. Hendrickson skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

LABORATORY

Testing • Research Consulting

Sample: 52824

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#3
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. . Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM. 05/18/2001, and collected at 10:45 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	0.9 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	28 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.2 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.3 mg/L	0.1 mg/L	05/25/2001
Phosphate-365.2	0.6 mg/L	0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2	0.5 mg/L	0.1 mg/L	05/21/2001
Turbidity-EPA180.1	60 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	4,000 cfu/100 mL	10 cfu/100 ml	05/19/2001

*Minimum Detection Level

This testing was completed by .E. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL
HML
LABORATORY

Testing • Research • Consulting

Sample: 52825

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#4
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 9:50 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	0.3 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	33 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.1 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.3 mg/L	0.1 mg/L	05/25/2001
Phosphate-365.2	1.1 mg/L	0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2	0.9 mg/L	0.1 mg/L	05/21/2001
Turbidity-EPA180.1	61 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	5,000 cfu/100 mL	10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us we can be of further service to you.

Sincerely,

Donald A Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML™

LABORATORY

Testing Research Consulting

Sample: 52826

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#5
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM. 05/18/2001, and collected at 9:38 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	0.3 mg/L		06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	37 mg/L		05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.1 mg/L		05/21/2001
Nitrogen, ammonia-350.3	0.3 mg/L		05/25/2001
Phosphate-365.2	0.4 mg/L		05/22/2001
Phosphate, Ortho-EPA365.2	0.4 mg/L		05/21/2001
Turbidity-EPA180.1	18 NTU		05/18/2001
Fecal Coliform-SM9222D (MF)	6,000 cfu/100 mL		05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely

Donald A. Hendrickson /skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL LABORATORY

Testing • Research • Consulting

Sample: 52827

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#6
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 9:05 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	2.8 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	19 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.2 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.4 mg/L	0.1 mg/L	05/25/2001
Phosphate-365.2	1.1 mg/L	0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2	1.0 mg/L	0.1 mg/L	05/21/2001
Turbidity-EPA180.1	101 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	50,000 cfu/100 mL	10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely,

Donald A. Hendrickson /skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

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Sample: 52828

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#7
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 9:30 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4		1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D		0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B		0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3		0.1 mg/L	05/25/2001
Phosphate-365.2		0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2		0.1 mg/L	05/21/2001
Turbidity-EPA180.1		1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)		10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely

Donald A. Hendrickson /skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL LABORATORY

Testing Research • Consulting

Sample: 52829

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#8
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML Inc. at 12:40 PM, 05/18/2001, and collected at 9:25 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4	1.5 mg/L	1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D	23 mg/L	0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.1 mg/L	0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	05/25/2001
Phosphate-365.2	0.5 mg/L	0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2	0.4 mg/L	0.1 mg/L	05/21/2001
Turbidity-EPA180.1	81 NTU	1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)	10,000 cfu/100 ml	10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by .E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely,

Donald A. Hendr ksor /skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL
HML
LABORATORY

Testing Research Consulting

Sample: 52830

June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#9
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 8:55 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4		1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D		0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B		0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3		0.1 mg/L	05/25/2001
Phosphate-365.2		0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2		0.1 mg/L	05/21/2001
Turbidity-EPA180.1		1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)		10 cfu/100 m	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely

Donald A. Hendrickson /skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL
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LABORATORY

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Sample: 52831
June 5, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Union Co. SWCD-00-0681M
#10
Silver & Hanna's Creeks Watersheds
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 12:40 PM 05/18/2001, and collected at 8:45 AM, 05/18/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, total (Kjeldahl)-351.4		1.0 mg/L	06/01/2001
Nitrogen, nitrate-SM 4500-NO3-D		0.1 mg/L	05/21/2001
Nitrogen, Nitrite-SM 4500-NO2-B		0.01 mg/L	05/21/2001
Nitrogen, ammonia-350.3		0.1 mg/L	05/25/2001
Phosphate-365.2		0.3 mg/L	05/22/2001
Phosphate, Ortho-EPA365.2		0.1 mg/L	05/21/2001
Turbidity-EPA180.1		1 NTU	05/18/2001
Fecal Coliform-SM9222D (MF)		10 cfu/100 mL	05/19/2001

*Minimum Detection Level

This testing was completed by J.E. and P.H. Please feel free to contact us if we can be of further service to you

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

SAGAMORE ENVIRONMENTAL SERVICES, INC.

CHAIN OF CUSTODY

8002 Castleway Dr. #104 • Indianapolis, IN 46250 • (317) 842-0510

Page 1 of 1

PROJECT NAME SILVER & HANNA'S CREEKS WATERSHEDS

PROJECT LOCATION UNION COUNTY, INDIANA LABORATORY QUOTE NUMBER

SAGAMORE PROJECT NUMBER 00-0681m SAGAMORE PROJECT MANAGER J. Hignite

SAMPLED BY

JASON HIGNITE (PRINT NAME) [signature] SIGNATURE

(PRINT NAME) SIGNATURE

							ANALYSIS							
SAMPLE #	DATE	TIME	SAMPLE DESCRIPTION	GRAB	COMP	# CONT.	TKN	NO3-NO2	AMMONIA N	TOTAL P	ORTHO P	TURBIDITY	FECAL COLIFORM	COMMENTS
1		1006	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
2		1018	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
3		1045	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
4		0950	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
5		0938 ~~0905~~	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
6		0905	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
7		0930	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
8		0925	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
9		0855	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	
10		0845	SURFACE WATER HF	✓			✓	✓	✓	✓	✓	✓	✓	

CONDITION OF SAMPLE: BOTTLES INTACT? ☐ YES ☐ NO COC SEALS PRESENT AND INTACT? ☐ YES ☐ NO VOLATILES FREE OF HEADSPACE? ☐ YES ☐ NO

SAMPLE REMAINDER DISPOSAL: ☐ RETURNED TO SAGAMORE ☐ DISPOSE TEMPERATURE AT RECEIPT:

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	RELINQUISHED BY:	DATE/TIME	RECEIVED FOR LABORATORY BY:
[signature]	5-18-01 12:40			5-18-01 12:40	Michelle Bryant
METHOD OF SHIPMENT: DELIVERY		REMARKS: RETURN COLD PACKS WITH COOLER			

ORIGINAL - WHITE LAB COPY - YELLOW FILE COPY - PINK

APPENDIX J

Laboratory Report: Low Flow

HOOSIER MICROBIOLOGICAL

HML

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Testing • Research • Consulting

Sample: 60924

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 2 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 1:40 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	8.6 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.8 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.4 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	<0.1 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	180 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	0.6 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.2 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/SKP

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

LABORATORY

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Sample: 60925

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 3 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 1:50 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	9.4 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	<0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.9 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	<0.1 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	380 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	0.5 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.2 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML™

LABORATORY

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Sample: 60926

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 4 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 1:00 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	11 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.4 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.1 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	<0.1 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	360 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	0.9 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.4 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

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Sample: 60927

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 5 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 12:55 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	15 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.1 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.1 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.4 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	230 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	0.7 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.5 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL LABORATORY

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Sample: 60928

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 6 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 2:05 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	5.4 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.02 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.2 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.2 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	1810 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	29.8 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.6 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/SKP

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

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Sample: 60929

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 7 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 2:00 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	6.8 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.2 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.4 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	500 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	3.2 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.5 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

HML

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Sample: 60930

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 8 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 12:20 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	3.1 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.01 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.3 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.1 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	290 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	2.6 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.4 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL LABORATORY

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Sample: 60931

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 9 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 12:30 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	4.7 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.02 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.4 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.3 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.2 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	990 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	4.3 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.3 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/skp

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

HOOSIER MICROBIOLOGICAL

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Sample: 60932

October 9, 2001

Mr. Jason Hignite
Sagamore Environmental Services
8002 Castleway Dr. Suite 104
Indianapolis, IN 46250

RE: PWS ID#: Unavailable
Silver Creek & Hanna's Creek-00-0681M
Point 10 low flow
Unavailable
Unavailable

Dear Mr. Hignite:

The following are the result(s) of the test(s) performed on the sample(s) received at HML, Inc. at 3:45 PM, 09/17/2001, and collected at 12:40 PM, 09/17/2001:

TEST - METHOD	RESULT	MDL*	Date Complete
Nitrogen, nitrate-SM 4500-NO3-D	15 mg/L	0.1 mg/L	09/20/2001
Nitrogen, Nitrite-SM 4500-NO2-B	0.04 mg/L	0.01 mg/L	09/18/2001
Nitrogen, total (Kjeldahl)-351.4	0.2 mg/L	1.0 mg/L	10/05/2001
Nitrogen, ammonia-350.3	0.2 mg/L	0.1 mg/L	09/21/2001
Phosphorus-200.7	<0.1 mg/L	0.1 mg/L	10/01/2001
Phosphate, Ortho-EPA365.2	0.1 mg/L	0.1 mg/L	09/19/2001
Fecal Coliform-SM9222D (MF)	8,000 cfu/100mL	10 cfu/100 mL	09/18/2001
Turbidity-EPA180.1	1.0 NTU	0.1 NTU	09/27/2001
Phosphate-365.2	0.3 mg/L	0.1 mg/L	09/26/2001

*Minimum Detection Level

This testing was completed by K.N. and D.B. and P.H. Please feel free to contact us if we can be of further service to you.

Sincerely,

Donald A. Hendrickson/SKP

Donald A. Hendrickson, Ph.D.
President - Microbiologist
Chemistry Lab #C-18-01
Microbiological Lab #M-18-03

DAH/skp

SAGAMORE ENVIRONMENTAL SERVICES, INC

CHAIN OF CUSTODY

8002 Castleway Dr. #104 • Indianapolis, IN 46250 • (317) 842-0510

PROJECT NAME: Silver Creek & Hanna's Creek

PROJECT LOCATION: Union Co., Indiana

LABORATORY QUOTE NUMBER:

SAGAMORE PROJECT NUMBER: 00-0681M

SAGAMORE PROJECT MANAGER: J. Hignite

SAMPLED BY

Jessica Manifold (PRINT NAME) SIGNATURE

(PRINT NAME) SIGNATURE

SAMPLE #	DATE	TIME	SAMPLE DESCRIPTION	GRAB	COMP	# CONT.	Nitrate-Nitrite	TKN	Ammonia N	Total P	Ortho P	Fecal Coliform	Turbidity		COMMENTS
1	9/17	1:4[illegible]	Point 1 Low Flow	✓			✓	✓	✓	✓	✓	✓	✓		
2	"	[illegible]	" 2 "	✓			✓	✓	✓	✓	✓	✓	✓		
3	"	1:50	" 3 "	✓			✓	✓	✓	✓	✓	✓	✓		
4	"	1:00	" 4 "	✓			✓	✓	✓	✓	✓	✓	✓		
5	"	12:55	" 5 "	✓			✓	✓	✓	✓	✓	✓	✓		
6	"	2:05	" 6 "	✓			✓	✓	✓	✓	✓	✓	✓		
7	"	12:00	" 7 "	✓			✓	✓	✓	✓	✓	✓	✓		
8	"	12:20	" 8 "	✓			✓	✓	✓	✓	✓	✓	✓		
9	"	12:30	" 9 "	✓			✓	✓	✓	✓	✓	✓	✓		
10	"	12:40	" 10 "	✓			✓	✓	✓	✓	✓	✓	✓		

CONDITION OF SAMPLE: BOTTLES INTACT? ☐ YES ☐ NO COC SEALS PRESENT AND INTACT? ☐ YES ☐ NO VOLATILES FREE OF HEADSPACE? ☐ YES ☐ NO

SAMPLE REMAINDER DISPOSAL: ☐ RETURNED TO SAGAMORE ☐ DISPOSE TEMPERATURE AT RECEIPT:

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:	RELINQUISHED BY:	DATE/TIME	RECEIVED FOR LABORATORY BY:
[signature]	9/19, 3:45				Michelle Bryant
METHOD OF SHIPMENT:		REMARKS: RETURN COLD PACKS WITH COOLER			

ORIGINAL - WHITE LAB COPY - YELLOW FILE COPY - PINK

APPENDIX K

Macroinvertebrate Identification Report

Station 3

Taxa	Family	Count		Remarks or common names
Annelida	Hirudinidae	1		leech
Isopoda	Asellidae	1		Aquatic sow bugs
Collembola	-----	1		Springtails
Ephemeroptera	Baetidae	22		Mayflies
	Heptogeniidae	2		Mayflies
	Oligoneuridae	5		Mayflies (+1 pupa)
Odonata	Calopterygidae	8		Damselflies
Hemiptera		0		--
Trichoptera	Hydropsychidae	140		Caddisflies
	Psychomyiidae	2		Caddisflies
Coleoptera	Elmidae	5	I.	Riffle beetles
	Haliplidae	3	A.	Crawling water beetles
	Hydrophilidae	1	A.	Water scavenger beetles
	Chrysomelidae	4	I.	Leaf beetles (semi aquatic)
	Psephenidae	8	I.	Adults terrestrial, larvae aquatic
Diptera	Chironomidae	7	I.	Midgeflies
	Tabanidae	2	I.	Horseflies
Gastropoda	Physidae	2		Snails

Station 4

Taxa	Family	Count		Remarks or common names
Isopoda	Asellidae	3		Aquatic sow bugs
Ephemeroptera	Heptageniidae	6		Mayflies
Odonata	Calopterygidae	1		Damselflies
	Gomphidae	1		Dragonflies
Hemiptera	Saldidae	1		True bugs
Trichoptera	Hydropsychidae	10		Caddisflies
Coleoptera	Elmidae	3	I.	Riffle beetles
	Hydrophillidae	5	A.	Water scavenger beetles
Diptera	Chironomidae	2	I.	Midgeflies
	Tipulidae	1	I.	Craneflies
Gastropoda	Physidae	1		Snails

Station 5

Taxa	Family	Count		Remarks or common names
Turbellaria	Planariidae	1		Planaria
Isopada	Asellidae	39		Aquatic sow bugs
Collembola		1		Springtails
Ephemeroptera	Baetidae	2	I.	Mayflies
	Baetidae	2		Pupa
Odonata	Calopterygidae	7		Damselflies
Hemiptera	Corixidae	1		Water boatman
	Veliidae	2		Broad-shouldered water striders
	Saldidae	1		True bugs
Trichoptera	Hydropsychidae	6		Caddisflies
	Polycentropodidae	1		Caddisflies
	Psychomyiidae	3		Caddisflies
Coleoptera	Elmidae	6	A.	Riffle beetles
	Elmidae	1	I.	Riffle beetles
	Hydrophilidae	1	A.	Water scavenger beetles
Diptera	Chironomidae	10	I.	Midgeflies
	Chironomidae	1		Pupa
	Ceratopogonidae	2	I	----
Gastropoda	Physidae	3		Snails

Station 6

Taxa	Family	Count		Remarks or common names
Turbellaria	Planaridae	1		Planaria
Isopada	Asellidae	4		Aquatic sow bugs
Amphipoda	Gammaridae	2		Scuds
Ephemeroptera	Heptageniidae	3		Mayflies
Odonata	Calopterygidae	10		Damselflies
	Coenagrionidae	4		Damselflies
	Gomphidae	2		Dragonflies
Hemiptera	Gerridae	4		Water striders
Trichoptera	Hydropsychidea	18		Caddisflies
Coleoptera	Elmidae	1	I.	Riffle beetles
	Elmidae	3	A.	Riffle beetles
	Haliplidae	1	A.	Crawling water beetles
Diptera	Chironomidae	6	I.	Midgeflies
	Culicidae	1	I.	Mosquitoes
		1		Pupa mosquitoes
	Stratiomyidae	1	I.	Soldierflies
Gastropoda	Physidae	4		Snails

Station 7

Taxa	Family	Count		Remarks or common names
Ephimeroptera	Baetidae	1		Mayflies
Trichoptera	Hydropsychidae	5		Caddisflies
Coleoptera	Elimidae	3	I.	Riffle beetles
	Psephenidae	2	I.	Riffle beetles
Diptera	Chironomidae	1	I.	Midgeflies
	Chironomidae	1		Pupa Midgeflies
	Tipulidae	1	I.	Craneflies

Station 8

Taxa	Family	Count		Remarks or common names
Annelida	Hirudinidae	1		Leech
Ephemeroptera	Baetidae	1		Mayflies
	Heptageniidae	2		Mayflies
Odonata	Calopterygidae	1		Damselflies
	Coenagrionidae	1		Damselflies
Trichoptera	Hydropsychidae	15		Caddisflies
Coleoptera	Elmidae	1	A.	Riffle beetles
	Elmidae		I.	Riffle beetles
Diptera	Chironomidae	3		Midgeflies
	Stratiomyidae	3		Soldierflies

Station 9

Taxa	**Family**	**Count**		**Remarks or common names**
Turbellaria	Planaridae	1		Planaria
Annelida	Hirudinidae	2		Leech
Isopoda	Asellidae	7		Aquatic sow bugs
Ephimeroptera	Baetidae	10		Mayflies
	Heptageniidae	2		Mayflies
Odonata	Calopterygidae	7		Damselflies
Trichoptera	Hydropsychidae	63		Caddisflies
	Psychomyiidae	1		Caddisflies
Coleoptera	Elmidae	11	A.	Riffle beetles
	Elmidae	25	I.	Riffle beetles
	Psephenidae	2	I.	---
	Carabidae	1	A.	Found around water
	Staphylinidae	2	A.	Rove beetles
	Heteroceridae	1	A.	
Diptera	Chironomidae	18	I.	Midgeflies
	Tipulidae	6	I.	Craneflies
	Anthomyiidae	2	I.	Immature stages found in streams
	Sciomyzidae	1	I.	Marshflies
Gastropoda	Physidae	20		Snails
Pelecypoda	Spheriidae	2		Fingernail clams

Station 10

Taxa	Family	Count		Remarks or common names
Annelida	Hirudinidae	1		Leech
Turbellaria	Planeriidae	7		Planaria
Hydracarina		1		Water mites
Hydracarina		1		Spiders
Isopoda	Asellidae	10		Aquatic sow bugs
Ephemeroptera	Baetidae	6		Mayflies
Odonata	Calopterygidae	15		Damselflies
	Coenagrionidae	1		Damselflies
Hemiptera	Corixidae	1		Water boatman
	Macroveliidae	2		Broad-shouldered water striders
Trichoptera	Hydropsychidae	27		Caddisflies
Coleoptera	Elmidae	4	A.	Riffle beetles
	Elimidae	19	I.	Riffle beetles
Diptera	Chironomidae	62	I.	Midgeflies
		1		Pupa Midgeflies
	Culicidae	1	I.	Mosquitoes
	Tipulidae	2	I.	Craneflies
		1		Pupa Craneflies
	Tabanidae	1	I.	Horseflies
	Muscidae	2	I.	Limnophora sp
	Ephydridae	1		Shoreflies
	Simuliidae	5	I.	Blackflies
Gastropoda	Physidae	18		Snails
		8		Empty shells
	Planorbidae	1		Snails
Pelecypoda	Sphaeriidae	2		Empty shells
		4		Fingernail clams

APPENDIX L

Physical Characterization/Water Quality Field Data Sheets and Benthic Macroinvertebrate Field Data Sheets

(1)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ______ ☐ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources — ATVs **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☒ Grasses ☒ Herbaceous **dominant species present** Golden Rod, knotweed, Sycamore, willow, walnut
INSTREAM FEATURES	**Estimated Reach Length** ______ m 100 m **Estimated Stream Width** ______ m 20.5 ft. **Sampling Reach Area** ______ m^2 **Area in km^2 (m^2x1000)** ______ km^2 **Estimated Stream Depth** ______ m 1.5 ft. **Surface Velocity (at thalweg)** ______ m/sec **Canopy Cover** ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** ______ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle ______% ☐ Run ______% ☐ Pool ______% **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	LWD ______ m^2 Log Jam **Density of LWD** ______ m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION None	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** ______ **Portion of the reach with aquatic vegetation** ____%
WATER QUALITY	**Temperature** ______ °C **Specific Conductance** ______ **Dissolved Oxygen** ______ **pH** ______ **Turbidity** ______ **WQ Instrument Used** ______ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ______ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ______ **Turbidity (if not measured)** ☐ Clear ☒ Slightly turbid ☐ Turbid ☒ Opaque ☐ Stained ☐ Other ______
SEDIMENT/ SUBSTRATE	**Odors** ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☒ None ☒ Other Slight fish odor **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☒ Other Gravel **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME [illegible] Creek	LOCATION # 1	
STATION # 1 RIVERMILE ____	STREAM CLASS	
LAT ____ LONG ____	RIVER BASIN	
STOREТ #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY J. Bolin	DATE 9/6/01 TIME 0830 AM PM	REASON FOR SURVEY Macro

HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ Cobble ____ % ☐ Snags 20 % ☐ Vegetated Banks 80 % ☐ Sand ____ % ☐ Submerged Macrophytes ____ % ☒ Other (2.8.4) 20 %
SAMPLE COLLECTION	**Gear used** ☒ D-frame ☐ kick-net ☒ Other ____ **How were the samples collected?** ☒ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☐ Cobble ____ ☐ Snags ____ ☐ Vegetated Banks 16 ☐ Sand ____ ☐ Submerged Macrophytes ____ ☒ Other (Riffles) 4
GENERAL COMMENTS	#crayfish = ∅

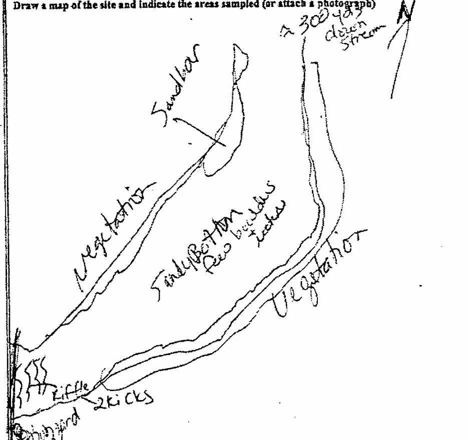
QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME Hanna's	LOCATION Rutherford
STATION # 2 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STOREET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY A Crump	DATE 9/4/01 TIME 9:45 AM PM — REASON FOR SURVEY Macro

WEATHER CONDITIONS Sunny clear	Now / Past 24 hours: ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ☐ %cloud cover ☒ clear/sunny — Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No — Air Temperature 70 °C — Other
SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION	Stream Subsystem ☒ Perennial ☐ Intermittent ☐ Tidal — Stream Type ☒ Coldwater ☐ Warmwater — Stream Origin ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☐ Spring-fed ☒ Mixture of origins ☐ Other — Catchment Area ____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ____ ☐ Residential **Local Watershed NPS Pollution** ☒ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☒ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☒ Grasses ☒ Herbaceous **dominant species present** ____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 20 m **Sampling Reach Area** ____ m² **Area in km² (m²x1000)** ____ km² **Estimated Stream Depth** 1.5 m **Surface Velocity (at thalweg)** ____ m/sec **Canopy Cover** E side full W side open ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** ____ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 70 % ☐ Run ____ % ☐ Pool ____ % **Channelized** ☒ Yes ☐ No slight **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** ____ m² **Density of LWD** ____ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** Cradads **Portion of the reach with aquatic vegetation** ____ %
WATER QUALITY	**Temperature** ____ °C **Specific Conductance** ____ **Dissolved Oxygen** ____ **pH** ____ **Turbidity** ____ **WQ Instrument Used** ____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☒ Fishy + dead ☐ Other cow smell **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other ____ **Turbidity (if not measured)** ☐ Clear ☒ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ____ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☐ Other ____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Hanna	LOCATION Rutherford
STATION # 2 RIVERMILE ______	STREAM CLASS U
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY Sag
INVESTIGATORS Crump/Bolin/Kidd	LOT NUMBER
FORM COMPLETED BY H Crump	DATE ____ TIME ____ AM PM / REASON FOR SURVEY macro.

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble____% ☐ Snags____% ☐ Vegetated Banks____% ☐ Sand____% ☐ Submerged Macrophytes____% ☐ Other (________)____%
SAMPLE COLLECTION	Gear used ☑ D-frame ☑ Kick-net ☐ Other ______ How were the samples collected? ☐ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble____ ☐ Snags____ ☑ Vegetated Banks 18 ☑ Sand____ ☐ Submerged Macrophytes____ ☐ Other (Riffle) 2
GENERAL COMMENTS	#crayfish = (50-60 noted in creek) 1 crawdad in riffle

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(FRONT)

STREAM NAME Hannah's	LOCATION
STATION # 3 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS Crump/ Kidd/ Bolin	
FORM COMPLETED BY A Crump	DATE 9/6 TIME 10:50 AM PM / REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
☐ %	%cloud cover	☐ %
☐	clear/sunny	☐

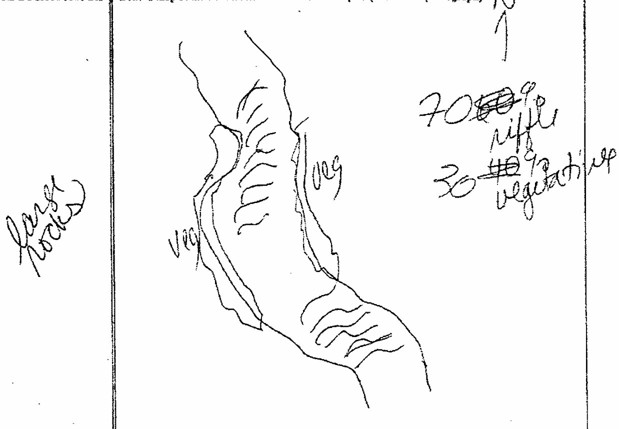
Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No

Air Temperature 80 °C

Other

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☐ Other

Catchment Area ______ km^2

(3)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES treatment creek w/ field Div	Predominant Surrounding Landuse ☒ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other ______ ☐ Residential	Local Watershed NPS Pollution ☐ No evidence ☐ Some potential sources ☐ Obvious sources Local Watershed Erosion ☒ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	Indicate the dominant type and record the dominant species present ☒ Trees ☐ Shrubs ☒ Grasses ☐ Herbaceous dominant species present ______	
INSTREAM FEATURES	Estimated Reach Length 100 m Estimated Stream Width 15 m Sampling Reach Area ______ m^2 Area in km^2 (m^2x1000) ______ km^2 Estimated Stream Depth <1 m Surface Velocity ______ m/sec (at thalweg)	Canopy Cover ☐ Partly open ☐ Partly shaded ☐ Shaded High Water Mark ______ m Proportion of Reach Represented by Stream Morphology Types ☐ Riffle ____% ☐ Run ____% ☐ Pool ____% Channelized ☐ Yes ☐ No Dam Present ☐ Yes ☐ No
LARGE WOODY DEBRIS	LWD ______ m^2 Density of LWD ______ m^2/km^2 (LWD/ reach area)	n/o
AQUATIC VEGETATION	Indicate the dominant type and record the dominant species present ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae dominant species present ______ Portion of the reach with aquatic vegetation ____%	
WATER QUALITY	Temperature ______ °C Specific Conductance ______ Dissolved Oxygen ______ pH ______ Turbidity ______ WQ Instrument Used ______	Water Odors ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ______ Water Surface Oils ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ______ Turbidity (if not measured) ☒ Clear ☒ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ______
SEDIMENT/ SUBSTRATE	Odors ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ______ Oils ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse	Deposits ☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand ☐ Relict shells ☐ Other ______ Looking at stones which are not deeply embedded, are the undersides black in color? ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Fanno	LOCATION Fosdick
STATION # 3 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS Bolin / Kidd / Crump	LOT NUMBER
FORM COMPLETED BY A. Crump	DATE 8/9/6 TIME 11 AM PM / REASON FOR SURVEY Macro

HABITAT TYPES	Indicate the percentage of each habitat type present ☐ Cobble 55 % ☐ Snags ____ % ☐ Vegetated Banks 30 % ☐ Sand ____ % ☐ Submerged Macrophytes ____ % ☐ Other ( ) ____ %
SAMPLE COLLECTION	Gear used ☒ D-frame ☒ kick-net ☐ Other ____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☐ Cobble ____ ☐ Snags ____ ☐ Vegetated Banks ____ ☐ Sand ____ ☐ Submerged Macrophytes ____ ☐ Other ( ) ____
GENERAL COMMENTS	#crayfish = None

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME	LOCATION 4
STATION # 4 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 9/16 TIME 10:15 AM PM — REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
%☐	%cloud cover	☐ %
☒	clear/sunny	☒

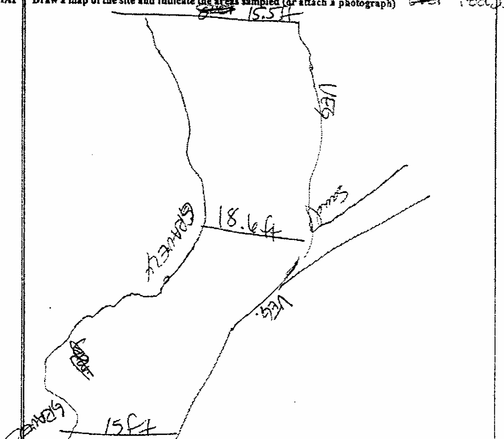
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No

Air Temperature 25 °C

Other

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph) ~~[illegible]~~ pool 4



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☐ Other

Catchment Area ________ km²

4

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(BACK)

construction downstream

WATERSHED FEATURES

Predominant Surrounding Landuse
- ☒ Forest
- ☐ Field/Pasture
- ☐ Agricultural
- ☐ Residential
- ☐ Commercial
- ☐ Industrial
- ☐ Other ________

Local Watershed NPS Pollution
- ☐ No evidence
- ☒ Some potential sources
- ☐ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☒ Trees ☐ Shrubs ☐ Grasses ☒ Herbaceous

dominant species present Sycamore, willow, Jewelweed

INSTREAM FEATURES

Estimated Reach Length ______ m

Estimated Stream Width ______ m

Sampling Reach Area ______ m^2

Area in km^2 (m^2x1000) ______ km^2

Estimated Stream Depth ______ m

Surface Velocity (at thalweg) ______ m/sec

Canopy Cover
☒ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark .24 m

Proportion of Reach Represented by Stream Morphology Types
☒ Riffle 80 % ☒ Run 20 %
☐ Pool ______ %

Channelized ☐ Yes ☐ No

Dam Present ☐ Yes ☒ No

LARGE WOODY DEBRIS

LWD ______ m^2

Density of LWD ______ m^2/km^2 (LWD/ reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating
☐ Floating Algae ☐ Attached Algae

dominant species present ________________

Portion of the reach with aquatic vegetation ______ %

WATER QUALITY

Temperature ______ °C

Specific Conductance ______

Dissolved Oxygen ______

pH ______

Turbidity ______

WQ Instrument Used ______________

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other ______

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☒ None ☐ Other ______

Turbidity (if not measured)
☒ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other ______

SEDIMENT/ SUBSTRATE

Odors
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other ______

Oils
☒ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand
☐ Relict shells ☐ Other ______

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	10
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	60	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	10	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION 4	
STATION # 4 RIVERMILE ____	STREAM CLASS	
LAT ____ LONG ____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE 9/16 TIME 10:15 AM PM	REASON FOR SURVEY

HABITAT TYPES	**Indicate the percentage of each habitat type present** ☒ Cobble 50 % ☐ Snags ____ % ☒ Vegetated Banks 50 % ☐ Sand ____ % ☐ Submerged Macrophytes ____ % ☐ Other (~~Riffle~~) ____ %
SAMPLE COLLECTION	**Gear used** ☒ D-frame ☒ kick-net ☐ Other ____ **How were the samples collected?** ☒ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☒ Cobble 10 ☐ Snags ____ ☒ Vegetated Banks 10 ☐ Sand ____ ☐ Submerged Macrophytes ____ ☐ ~~Other (Riffle~~ ____
GENERAL COMMENTS	#crayfish = 1 2 fish

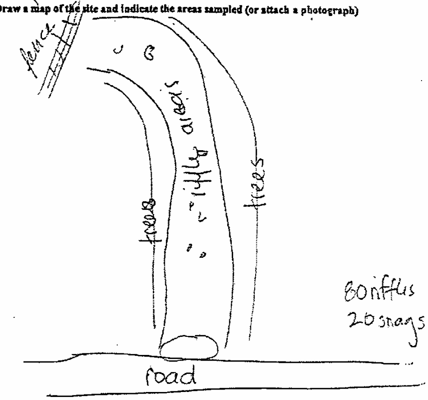
QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME	LOCATION #5
STATION # 5 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS LMS, NV	
FORM COMPLETED BY Lynn	DATE 9/11 TIME 11:45 AM PM — REASON FOR SURVEY

WEATHER CONDITIONS Sunny 80°	**Now** / **Past 24 hours** ☐ storm (heavy rain) ☐ ☐ rain (steady rain) ☐ ☐ showers (intermittent) ☐ %☐ %cloud cover ☐ ___% ☑ clear/sunny ☐ **Has there been a heavy rain in the last 7 days?** ☐ Yes ☐ No **Air Temperature** ____ °C **Other** ____
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)**



STREAM CHARACTERIZATION	**Stream Subsystem** ☐ Perennial ☐ Intermittent ☐ Tidal **Stream Type** ☐ Coldwater ☐ Warmwater **Stream Origin** ☐ Glacial ☐ Spring-fed ☐ Non-glacial montane ☐ Mixture of origins ☐ Swamp and bog ☐ Other ____ **Catchment Area** ____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other ____ ☐ Residential	**Local Watershed NPS Pollution** ☐ No evidence ☒ Some potential sources ☐ Obvious sources COWS **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☒ Shrubs ☒ Grasses ☐ Herbaceous dominant species present ____	
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 15ft m **Sampling Reach Area** ____ m^2 **Area in km^2 (m^2x1000)** ____ km^2 **Estimated Stream Depth** 2 inches **Surface Velocity (at thalweg)** ____ m/sec	**Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** ____ m **Proportion of Reach Represented by Stream Morphology Types** ☒ Riffle 90 % ☐ Run 5 % ☐ Pool 5 % **Channelized** ☐ Yes ☒ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** ____ m^2 **Density of LWD** ____ m^2/km^2 (LWD/ reach area)	
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☒ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☒ Attached Algae dominant species present ____ Portion of the reach with aquatic vegetation 30 %	
WATER QUALITY	**Temperature** ____ °C **Specific Conductance** ____ **Dissolved Oxygen** ____ **pH** ____ **Turbidity** ____ **WQ Instrument Used** ____	**Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other ____ **Turbidity (if not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE one area w/ oils noted	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ____ **Oils** ☒ Absent ☒ Slight ☐ Moderate ☐ Profuse	**Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☒ Other 10(ill) **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	30%
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	80%	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	20%			
Sand	0.06-2mm (gritty)	trace	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	trace			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION #5
STATION # 5 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS LMS, NV	LOT NUMBER
FORM COMPLETED BY Lynn	DATE 9/10/2001 TIME 11:45 AM PM / REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 80 % ☒ Snags 20 % ☐ Vegetated Banks ____% ☐ Sand ____% ☐ Submerged Macrophytes ____% ☐ Other ( ) ____%
SAMPLE COLLECTION	Gear used ☒ D-frame ☒ kick-net ☐ Other ________ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 10 ☒ Snags 4 ☐ Vegetated Banks ____ ☐ Sand ____ ☐ Submerged Macrophytes ____ ☐ Other ( ) ____
GENERAL COMMENTS	#crayfish = 5

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

6

(FRONT)

STREAM NAME	LOCATION 6
STATION # 6 RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS JESSICA + ROB	
FORM COMPLETED BY JESSICA	DATE SAME TIME ______ AM PM — REASON FOR SURVEY SAME

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
___%☐	%cloud cover	☐ ___%
☒	clear/sunny	☒

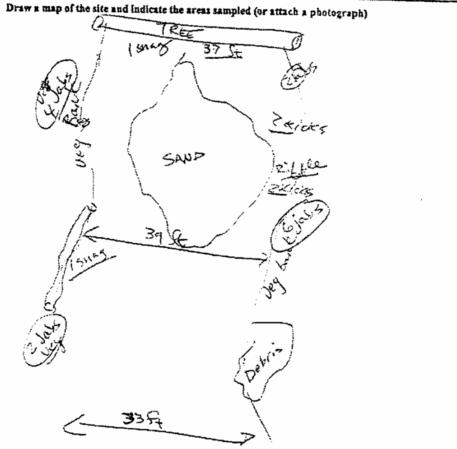
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No

Air Temperature 25 °F

Other______________

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☐ Other________

Catchment Area________km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☐ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ______ ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☐ Grasses ☒ Herbaceous **dominant species present** Sycamore, Jewelweed, Bidens, Black Willow
INSTREAM FEATURES	**Estimated Reach Length** ______ m **Estimated Stream Width** ______ m **Sampling Reach Area** ______ m² **Area in km² (m²x1000)** ______ km² **Estimated Stream Depth** ______ m **Surface Velocity (at thalweg)** ______ m/sec **Canopy Cover** ☒ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** 2 ft approx 1.2 ft avg **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle ______ % ☐ Run ______ % ☐ Pool ______ % **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** ______ m² **Density of LWD** ______ m²/km² (LWD/ reach area)
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** ______ **Portion of the reach with aquatic vegetation** ____ %
WATER QUALITY	**Temperature** ______ °C **Specific Conductance** ______ **Dissolved Oxygen** ______ **pH** ______ **Turbidity** ______ **WQ Instrument Used** ______ **Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ______ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ______ **Turbidity (if not measured)** ☐ Clear ☒ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ______
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ______ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☒ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☐ Other ______ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	10
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION 6	
STATION #____ RIVERMILE____	STREAM CLASS	
LAT ____ LONG ____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS Jessica + Rob		LOT NUMBER
FORM COMPLETED BY Jessica	DATE 8/9/16 TIME 8:15 AM PM	REASON FOR SURVEY MACRO INDICATORS

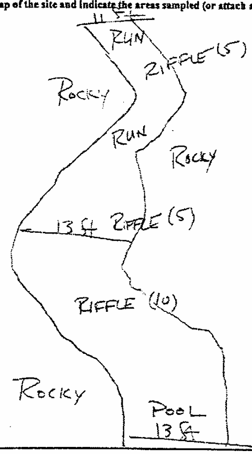
HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ Cobble___% ☒ Snags 10 % ☒ Vegetated Banks 70 % ☐ Sand___% ☐ Submerged Macrophytes___% ☒ Other (Riffle) 20 %
SAMPLE COLLECTION	**Gear used** ☐ D-frame ☒ kick-net ☐ Other ____ **How were the samples collected?** ☒ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☐ Cobble___ ☒ Snags 2 ☒ Vegetated Banks 14 ☐ Sand___ ☐ Submerged Macrophytes___ ☒ Other (Riffle) 4
GENERAL COMMENTS	#crayfish = 2

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME	LOCATION 7
STATION # 7 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS JESS + ROB	
FORM COMPLETED BY JESS	DATE 9/6/01 TIME 9:30 AM PM — REASON FOR SURVEY MACRO INDICATORS

WEATHER CONDITIONS	Now / Past 24 hours: ☐ ☐ storm (heavy rain); ☐ ☐ rain (steady rain); ☐ ☐ showers (intermittent); ___%☐ ☐___% %cloud cover; ☒ ☒ clear/sunny **Has there been a heavy rain in the last 7 days?** ☐ Yes ☐ No **Air Temperature** 25 °C **Other** ____
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)** 
STREAM CHARACTERIZATION	**Stream Subsystem** ☐ Perennial ☐ Intermittent ☐ Tidal **Stream Type** ☐ Coldwater ☐ Warmwater **Stream Origin** ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☐ Spring-fed ☐ Mixture of origins ☐ Other____ **Catchment Area** ____ km^2

7

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☒ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☐ Agricultural ☐ Other ________ ☐ Residential	**Local Watershed NPS Pollution** ☐ No evidence ☐ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☒ Herbaceous **dominant species present** BUSH, HICKORY, PINE STUFF, [illegible]	
INSTREAM FEATURES	**Estimated Reach Length** ______ m **Estimated Stream Width** ______ m **Sampling Reach Area** ______ m^2 **Area in km^2 (m^2x1000)** ______ km^2 **Estimated Stream Depth** ______ m **Surface Velocity (at thalweg)** ______ m/sec	**Canopy Cover** ☐ Partly open ☒ Partly shaded ☐ Shaded **High Water Mark** < 1 [illegible] **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle 50 % ☐ Run ~~[illegible]~~ 20 % ☐ Pool 30 % **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☒ No
LARGE WOODY DEBRIS	**LWD** ______ m^2 **Density of LWD** ______ m^2/km^2 (LWD/ reach area)	
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** ________ **Portion of the reach with aquatic vegetation** ____ %	
WATER QUALITY	**Temperature** ______ °C **Specific Conductance** ______ **Dissolved Oxygen** ______ **pH** ______ **Turbidity** ______ **WQ Instrument Used** ______	**Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ______ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ______ **Turbidity (if not measured)** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ______
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☒ Chemical ☐ Anaerobic ☐ None ☐ Other ______ **Oils** ☐ Absent ☐ Slight ☐ Moderate ☐ Profuse	**Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☐ Other ______ **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	80%	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	10 %	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10 %			
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT/WATER QUALITY FIELD DATA SHEET

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION 7	
STATION # 9 RIVERMILE	STREAM CLASS	
LAT LONG	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS JESS + ROB		LOT NUMBER
FORM COMPLETED BY JESS	DATE 9.30 TIME 9:16 AM PM	REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 80 % ☐ Snags ___ % ☐ Vegetated Banks ___ % ☒ Sand 20 % ☐ Submerged Macrophytes ___ % ☐ Other ( ) ___ %
SAMPLE COLLECTION	Gear used ☐ ~~D-frame~~ ☒ kick-net ☐ Other ________ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 16 ☐ Snags ___ ☐ Vegetated Banks ___ ☒ Sand 4 ☐ Submerged Macrophytes ___ ☐ Other ( ) ___
GENERAL COMMENTS	# crayfish = Ø

QUALITATIVE LISTING OF AQUATIC BIOTA

Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME	LOCATION 3
STATION # 5 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 9/16 TIME 11:30 AM PM — REASON FOR SURVEY

WEATHER CONDITIONS

Now		Past 24 hours
☐	storm (heavy rain)	☐
☐	rain (steady rain)	☐
☐	showers (intermittent)	☐
%☐	%cloud cover	☐ %
☒	clear/sunny	☒

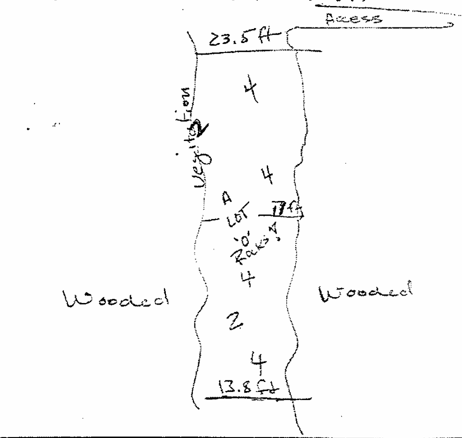
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No

Air Temperature 78 °F

Other

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☐ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☐ Mixture of origins
☐ Other

Catchment Area _______ km^2

8

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest ☐ Commercial
☐ Field/Pasture ☐ Industrial
☒ Agricultural ☐ Other ________
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☐ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☐ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☒ Trees ☐ Shrubs ☐ Grasses ☒ Herbaceous
dominant species present Goldenrod / Jewelweed, Willow

INSTREAM FEATURES

Estimated Reach Length ______ m
Estimated Stream Width ______ m
Sampling Reach Area ______ m^2
Area in km^2 (m^2x1000) ______ km^2
Estimated Stream Depth ______ m
Surface Velocity (at thalweg) ______ m/sec

Canopy Cover
☒ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark .34 m

Proportion of Reach Represented by Stream Morphology Types
☒ Riffle 100 % ☐ Run ______ %
☐ Pool 1 ______ %

Channelized ☐ Yes ☐ No
Dam Present ☐ Yes ☒ No

LARGE WOODY DEBRIS

LWD ______ m^2
Density of LWD ______ m^2/km^2 (LWD/ reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating
☐ Floating Algae ☐ Attached Algae

dominant species present ____________________

Portion of the reach with aquatic vegetation ____ %

WATER QUALITY

Temperature 70 °C
Specific Conductance ______
Dissolved Oxygen ______
pH ______
Turbidity ______
WQ Instrument Used ______

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other ______

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☐ None ☐ Other ______

Turbidity (if not measured)
☒ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other ______

SEDIMENT/ SUBSTRATE

Odors
☒ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other ______

Oils
☒ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand little
☐ Relict shells ☒ Other Boulder/Cobble

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach
Bedrock		
Boulder	> 256 mm (10")	90
Cobble	64-256 mm (2.5"-10")	10
Gravel	2-64 mm (0.1"-2.5")	
Sand	0.06-2mm (gritty)	
Silt	0.004-0.06 mm	
Clay	< 0.004 mm (slick)	

ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Characteristic	% Composition in Sampling Area
Detritus	sticks, wood, coarse plant materials (CPOM)	
Muck-Mud	black, very fine organic (FPOM)	
Marl	grey, shell fragments	

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME	LOCATION C	
STATION # C RIVERMILE	STREAM CLASS	
LAT LONG	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		LOT NUMBER
FORM COMPLETED BY	DATE 9/6 TIME 11:30 AM PM	REASON FOR SURVEY

HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ ~~Cobble~~ [illegible] % ☐ Snags ___ % ☐ Vegetated Banks 10 % ☐ Sand ___ % ☐ Submerged Macrophytes ___ % ☐ Other (Boulders) ~~90~~ 80 % Riffle areas
SAMPLE COLLECTION	**Gear used** ☒ D-frame ☒ kick-net ☐ Other ___ **How were the samples collected?** ☒ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☒ Cobble 2 ☐ Snags ___ ☒ Vegetated Banks 2 ☐ Sand ___ ☐ Submerged Macrophytes ___ ☒ Other ( ) 16
GENERAL COMMENTS	#crayfish = 2

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

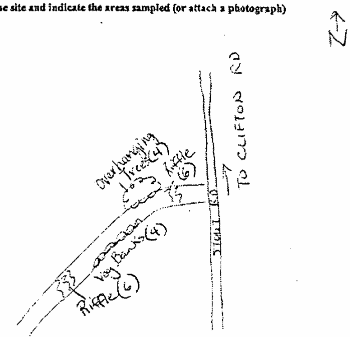
(FRONT)

STREAM NAME Silver Creek	LOCATION Site # 9
STATION # 9 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY Sagamore
INVESTIGATORS NLV, LMS, MR	
FORM COMPLETED BY NLV	DATE 9-6-01 TIME 10:30 AM PM — REASON FOR SURVEY Diagnostic Study

WEATHER CONDITIONS Sunny 80°	Now: ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ☐ ___% %cloud cover ☑ clear/sunny	Past 24 hours: ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ☐ ___% %cloud cover ☑ clear/sunny	Has there been a heavy rain in the last 7 days? ☑ Yes ☐ No Air Temperature ____ °C Other ________

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION	Stream Subsystem: ☑ Perennial ☐ Intermittent ☐ Tidal Stream Origin: ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☑ Spring-fed ☑ Mixture of origins ☐ Other____	Stream Type: ☐ Coldwater ☐ Warmwater Catchment Area ________ km²

(a)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☑ Field/Pasture ☐ Industrial ☑ Agricultural ☐ Other ____ ☐ Residential **Local Watershed NPS Pollution** ☐ No evidence ☑ Some potential sources ☐ Obvious sources **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous **dominant species present** ____
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 10' m **Sampling Reach Area** ____ m^2 **Area in km^2 (m^2x1000)** ____ km^2 **Estimated Stream Depth** 4" m **Surface Velocity** ____ m/sec **(at thalweg)** **Canopy Cover** ☑ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** ____ m **Proportion of Reach Represented by Stream Morphology Types** ☑ Riffle 60 % ☑ Run 10 % ☑ Pool 30 % **Channelized** ☐ Yes ☑ No **Dam Present** ☐ Yes ☑ No
LARGE WOODY DEBRIS	**LWD** ____ m^2 **Density of LWD** ____ m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☑ Rooted emergent ☑ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☑ Attached Algae **dominant species present** ____ **Portion of the reach with aquatic vegetation** 10 %
WATER QUALITY	**Temperature** ____ °C **Specific Conductance** ____ **Dissolved Oxygen** ____ **pH** ____ **Turbidity** ____ **WQ Instrument Used** ____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ____ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ None ☐ Other ____ **Turbidity (if not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ____
SEDIMENT/ SUBSTRATE	**Odors** ☑ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ____ **Oils** ☑ Absent ☐ Slight ☐ Moderate ☐ Profuse **Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☑ Sand ☐ Relict shells ☑ Other Silt **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	30%
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	20%	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	40%			
Sand	0.06-2mm (gritty)	30%	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10%			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Silver Creek	LOCATION Site #9	
STATION # 9 RIVERMILE ___	STREAM CLASS	
LAT ___ LONG ___	RIVER BASIN	
STOREТ #	AGENCY	
INVESTIGATORS NLV, LHS, MR		LOT NUMBER
FORM COMPLETED BY NLV	DATE 9-6-01 TIME 10:30 AM PM	REASON FOR SURVEY Diagnostic Study

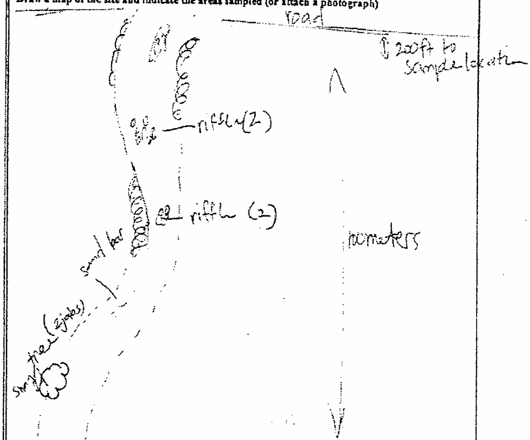
HABITAT TYPES	**Indicate the percentage of each habitat type present** ☐ Cobble 50% ☐ Snags ___% ☐ Vegetated Banks 40% ☐ Sand 10% ☐ Submerged Macrophytes ___% ☐ Other ( ) ___%
SAMPLE COLLECTION	**Gear used** ☑ D-frame ☑ kick-net ☐ Other ___ **How were the samples collected?** ☑ wading ☐ from bank ☐ from boat **Indicate the number of jabs/kicks taken in each habitat type.** ☑ Cobble 12 ☐ Snags ___ ☑ Vegetated Banks 8 ☐ Sand ___ ☐ Submerged Macrophytes ___ ☐ Other ( ) ___
GENERAL COMMENTS	#crayfish = 3

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3= Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

(FRONT)

STREAM NAME Silver Creek	LOCATION #10
STATION # 10 RIVERMILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS LMS, NV, MR	
FORM COMPLETED BY LMM	DATE 9/10/2001 TIME 9 AM PM / REASON FOR SURVEY

WEATHER CONDITIONS	Now / Past 24 hours: ☐ ☐ storm (heavy rain); ☐ ☐ rain (steady rain); ☐ ☐ showers (intermittent); ___% ☐ ☐ ___% %cloud cover; ☒ ☒ clear/sunny. **Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No. **Air Temperature** 15 °C. **Other**
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)** 
STREAM CHARACTERIZATION	**Stream Subsystem** ☐ Perennial ☐ Intermittent ☐ Tidal. **Stream Type** ☐ Coldwater ☐ Warmwater. **Stream Origin** ☐ Glacial ☐ Non-glacial montane ☐ Swamp and bog ☐ Spring-fed ☐ Mixture of origins ☐ Other ____. **Catchment Area** ____ km²

(10)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ☐ Forest ☐ Commercial ☒ Field/Pasture ☐ Industrial ☒ Agricultural ☐ Other ______ ☐ Residential	**Local Watershed NPS Pollution** ☐ No evidence ☒ Some potential sources ☐ Obvious sources cows upstream **Local Watershed Erosion** ☐ None ☐ Moderate ☐ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ☒ Trees ☐ Shrubs ☒ Grasses ☐ Herbaceous **dominant species present** ______	
INSTREAM FEATURES	**Estimated Reach Length** 100 m **Estimated Stream Width** 10ft wig **Sampling Reach Area** ______ m^2 **Area in km^2 (m^2x1000)** ______ km^2 **Estimated Stream Depth** 3 inches **Surface Velocity (at thalweg)** ______ m/sec	**Canopy Cover** ☐ Partly open ☐ Partly shaded ☐ Shaded **High Water Mark** ______ m **Proportion of Reach Represented by Stream Morphology Types** ☐ Riffle ______% ☐ Run ______% ☐ Pool ______% **Channelized** ☐ Yes ☐ No **Dam Present** ☐ Yes ☐ No
LARGE WOODY DEBRIS	**LWD** ______ m^2 **Density of LWD** ______ m^2/km^2 (LWD/ reach area)	
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ☒ Rooted emergent ☒ Rooted submergent ☐ Rooted floating ☐ Free floating ☐ Floating Algae ☐ Attached Algae **dominant species present** rooted (grass) **Portion of the reach with aquatic vegetation** ______%	
WATER QUALITY	**Temperature** ______ °C **Specific Conductance** ______ **Dissolved Oxygen** ______ **pH** ______ **Turbidity** ______ **WQ Instrument Used** ______	**Water Odors** ☒ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other ______ **Water Surface Oils** ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☒ None ☐ Other ______ **Turbidity (if not measured)** ☒ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other ______
SEDIMENT/ SUBSTRATE	**Odors** ☒ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None ☐ Other ______ **Oils** ☒ Absent ☐ Slight ☐ Moderate ☐ Profuse	**Deposits** ☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand ☐ Relict shells ☒ Other rocks & stones **Looking at stones which are not deeply embedded, are the undersides black in color?** ☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			**ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)**		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	5
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	20	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	40			
Sand	0.06-2mm (gritty)	40	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	trace			
Clay	< 0.004 mm (slick)				

BENTHIC MACROINVERTEBRATE FIELD DATA SHEET

STREAM NAME Silver Creek	LOCATION #10
STATION # 10 RIVERMILE ____	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS LMS, NV, MR	LOT NUMBER
FORM COMPLETED BY Lynn	DATE 9/6/2001 TIME 9:15 AM PM / REASON FOR SURVEY

HABITAT TYPES	Indicate the percentage of each habitat type present ☒ Cobble 20 % ☒ Snags 10 % ☒ Vegetated Banks 70 % ☐ Sand ___ % ☐ Submerged Macrophytes ___ % ☐ Other ( ) ___ %
SAMPLE COLLECTION	Gear used ☒ D-frame ☒ kick-net ☐ Other ____ How were the samples collected? ☒ wading ☐ from bank ☐ from boat Indicate the number of jabs/kicks taken in each habitat type. ☒ Cobble 4 ☒ Snags 2 ☒ Vegetated Banks 14 ☐ Sand ___ ☐ Submerged Macrophytes ___ ☐ Other ( ) ___
GENERAL COMMENTS	#crayfish = 0

QUALITATIVE LISTING OF AQUATIC BIOTA
Indicate estimated abundance: 0 = Absent/Not Observed, 1 = Rare, 2 = Common, 3 = Abundant, 4 = Dominant

Periphyton	0 1 2 3 4	Slimes	0 1 2 3 4
Filamentous Algae	0 1 2 3 4	Macroinvertebrates	0 1 2 3 4
Macrophytes	0 1 2 3 4	Fish	0 1 2 3 4

APPENDIX M

IDEM Macroinvertebrate Community Assessment

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OWQ - BIOLOGICAL STUDIES SECTION
MACROINVERTEBRATE COMMUNITY ASSESSMENT PROGRAM

Wednesday, May 09, 2001

SITE INFORMATION:

SAMPLE NUMBER:	KICK 94C0625103
EVENT ID:	
DATE COLLECTED:	August 25, 1994
SITE:	HANNA CREEK
LOCATION:	S.R. 101
COUNTY	UNION
LATITUDE	39 ° 34 ' 58.03 "
LONGITUDE	84 ° 58 ' 47.00 "
ECOREGION	55
HYDROLOGIC UNIT:	5080003050
DRAINAGE (SQ MILES):	160.20
GRADIENT (FT/MILE):	27.20

WATER CHEMISTRY:

TEMPERATURE (C):	20.68
DISSOLVED OXYGEN (mg/L)	9.9
CONDUCTIVITY (us/cm^2)	513
pH (su)	8.21

HABITAT SCORE (QHEI):

SUBST SCORE	20
INSTREAM COVER SCORE:	5
CHANNEL SCORE:	12
RIPARIAN ZONE SCORE	6
POOL_SCORE:	5
RIFFL SCORE:	4
GRADIENT SCORE	6
TOTAL SCORE:	57

COMMUNITY DATA & SUBMETRIC SCORES:

HBI	4.71	4
NUMBER OF INDIVIDUALS	314	6
NUMBER OF TAXA	18	3
% DOMINANT TAXON:	33.9	4
EPT_COUNT:	116	8
NUMBER OF EPT TAXA:	7	8
CHIRONOMID COUNT:	108	2
EPT/CHIRONOMID RATIO:	1.09	2
EPT/TOTAL RATIO	0.37	4
INDIVIDUALS/ SQUARE:	219	8
mIBI SCORE:		4.3

TAXONOMY:

COUNT	TAXA	HBI TOLERANCE VALUE
3	ASELLIDAE	8
9	BAETIDAE	4
2	CAENIDAE	7
8	OLIGONEURIIDAE	2
7	HEPTAGENIIDAE	4
2	PHILOPOTAMIDAE	3
3	HYDROPTILIDAE	4
85	HYDROPSYCHIDAE	4
6	PSEPHENIDAE	4
50	ELMIDAE	4
108	CHIRONOMIDAE(all others)	6
2	EMPIDIDAE	6
10	ACARI	4
10	TURBELLARIA	4
8	TUBIFICIDAE	
1	HEMIPTERA	
1	ISOTOMIDAE	
1	NEMATODA	

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OWQ - BIOLOGICAL STUDIES SECTION
MACROINVERTEBRATE COMMUNITY ASSESSMENT PROGRAM

Wednesday, May 09, 2001

SITE INFORMATION:

SAMPLE NUMBER:	KICK 940825101
EVENT ID.	-
DATE COLLECTED:	August 25, 1994
SITE:	SILVER CREEK
LOCATION:	BROWNSVILLE RD
COUNTY:	UNION
LATITUDE	39 ° 38 ' 30.00 "
LONGITUDE:	84 ° 50 ' 24.00 "
ECOREGION:	55
HYDROLOGIC UNIT:	5080003050
DRAINAGE (SQ MILES)	14.20
GRADIENT (FT/MILE)	35.10

WATER CHEMISTRY:

TEMPERATURE (C):	19.59
DISSOLVED OXYGEN (mg/L):	8.72
CONDUCTIVITY (uS/cm^2)	541
pH (su):	8.06

HABITAT SCORE (QHEI):

SUBST SCORE:	16
INSTREAM COVER SCORE:	9
CHANNEL SCORE:	13
RIPARIAN ZONE SCORE:	7
POOL_SCORE:	5
RIFFL SCORE:	6
GRADIENT SCORE:	8
TOTAL SCORE:	65

COMMUNITY DATA & SUBMETRIC SCORES:

HBI:	3.62	8
NUMBER OF INDIVIDUALS	127	2
NUMBER OF TAXA	13	4
% DOMINANT TAXON	31.5	4
EPT_COUNT:	81	4
NUMBER OF EPT TAXA	6	8
CHIRONOMID COUNT:	12	8
EPT/CHIRONOMID RATIO:	6.75	8
EPT/TOTAL RATIO:	0.64	6
INDIVIDUALS/SQUARE	319	4
mIBI SCORE:		5.0

TAXONOMY:

COUNT	TAXA	HBI TOLERANCE VALUE
10	BAETIDAE	4
2	OLIGONEURIIDAE	2
4	HEPTAGENIIDAE	4
1	CORYDALIDAE	4
40	PHILOPOTAMIDAE	3
1	HELICOPSYCHIDAE	3
25	HYDROPSYCHIDAE	4
1	PSEPHENIDAE	4
25	ELMIDAE	4
12	CHIRONOMIDAE(other)	6
1	CERATOPOGONIDAE	6
1	ACARI	4
2	TUBIFICIDAE	

APPENDIX N

QHEI Field Data Sheets

SAGAMORE

Site Description Sheet

QHEI Score: 81

Project No: 00-0681M Stream: Hanna's Creek Date: 9/21/01 Sample Point: 1
Location: Hanna's Creek Outflow Crew: Hignite/Manifold

1) SUBSTRATE — SCORE: 16

TYPE	Pool	Riffle	TYPE	Pool	Riffle
Boulder/Slabs (10)			Gravel (7)	X	X
Boulder (9)		X	Sand (6)	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)			Detritus (3)	X	X
Muck (2)			Artificial (0)		

TOTAL NUMBER OF SUBSTRATE TYPES
Note: Ignore sludge that originates from point-sources. Score is based on natural substrates
☒ - >4 (2) ☐ - <= 4 (0)

SUBSTRATE QUALITY (Check one in each)

Silt Cover
- ☐ - Heavy (-2)
- ☒ - Moderate (-1)
- ☐ - Normal (0)
- ☐ - Silt Free (1)

Substrate Origin
- ☐ - Limestone (1)
- ☒ - Till (1)
- ☐ - Rip Rap (0)
- ☐ - Hardpan (0)
- ☐ - Sandstone (0)
- ☐ - Shale (-1)
- ☐ - Coal Fines (-2)

Extent of Embeddedness
- ☐ - Extensive (-2)
- ☐ - Moderate (-1)
- ☐ - Low (0)
- ☒ - None (1)

Comments:

2) INSTREAM COVER — SCORE: 15

TYPE
- ☐ - Undercut Banks (1)
- ☒ - Overhanging Vegetation (1)
- ☐ - Shallows (in slow water) (1)
- ☐ - Deep Pools (2)
- ☒ - Rootwads (1)
- ☒ - Boulders (1)
- ☐ - Oxbows (1)
- ☒ - Aquatic Macrophytes (1)
- ☒ - Logs or Woody Debris (1)

AMOUNT*
- ☐ - Extensive > 75% (11)
- ☒ - Moderate 25-75% (7)
- ☐ - Sparse 5-25% (3)
- ☐ - Nearly Absent < 5% (1)

* Check one or average two

Comments:

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 16

SINUOSITY
- ☐ - High (4)
- ☒ - Moderate (3)
- ☐ - Low (2)
- ☐ - None (1)

DEVELOPMENT
- ☐ - Excellent (7)
- ☒ - Good (5)
- ☐ - Fair (3)
- ☐ - Poor (1)

CHANNELIZATION
- ☒ - None (6)
- ☐ - Recovered (4)
- ☐ - Recovering (3)
- ☐ - Recent or No Recovery

STABILITY
- ☐ - High (3)
- ☒ - Moderate (2)
- ☐ - Low (1)

MODIFICATIONS/OTHER
- ☐ - Snagging
- ☐ - Impound
- ☐ - Relocation
- ☒ - Islands
- ☐ - Canopy Removal
- ☐ - Leveed
- ☐ - Dredging
- ☐ - Bank shaping
- ☐ - One Side Channel Modification

Comments:

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 9

RIPARIAN WIDTH
L R (Per Bank)
- ☐☐ - Wide > 165 ft. (4)
- ☐☐ - Moderate 33-165 ft. (3)
- ☐☐ - Narrow 17-33 ft. (2)
- ☐☐ - Very Narrow 3-17 ft. (1)
- ☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
- ☐☐ - Forest, Swamp (3)
- ☐☐ - Open Pasture, Row Crop (0)
- ☐☐ - Residence, Park, New Field (1)
- ☐☐ - Fenced Pasture (1)

L R (Per Bank)
- ☐☐ - Urban/Industrial (0)
- ☐☐ - Shrub/Fallow Field (2)
- ☐☐ - Conservation Tillage (1)
- ☐☐ - Mining/Construction (0)

BANK EROSION
L R
- ☐☐ - None/Little (3)
- ☐☐ - Moderate (2)
- ☐☐ - Heavy or Severe (1)

Comments: ATV trail through creek.

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 15

MAX. DEPTH (Check one)
- ☐ - > 3' (6)
- ☐ - 2' 4" - 3' (4)
- ☐ - 1' 4" - 2' 4" (2)
- ☐ - < 1' 4" (1)
- ☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
- ☐ - Pool Width > Riffle Width (2)
- ☐ - Pool Width = Riffle Width (1)
- ☐ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that apply)
- ☐ - Intermittent (-2)
- ☐ - Interstitial (-1)
- ☐ - Torrential (-1)
- ☐ - Fast (1)
- ☐ - Eddies (1)
- ☐ - Moderate (1)
- ☐ - Slow (0)
- ☐ - No Pool (0)

Comments:

RIFFLE/RUN DEPTH
- ☒ - Generally >4", Max >2' 8" (4)
- ☐ - Generally >4", Max <2' 8" (3)
- ☐ - Generally 2" - 4" (1)
- ☐ - Generally < 2" Riffle = 0

RIFFLE/RUN SUBSTRATE
- ☒ - Stable (e.g., Cobble, Boulder) (2)
- ☐ - Mod. Stable (e.g., Pea Gravel) (1)
- ☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
- ☐ - Extensive (-1)
- ☐ - Moderate (0)
- ☒ - Low (1)
- ☐ - None (2)
- ☐ - No Riffle (0)

Comments:

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 10.0
% Pool: 10
Average Stream Width: 27.7
%Riffle: 30
Drainage Area (sq. miles): 27.29
%Run: 60

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. [illegible], EPA [illegible]. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency. Ecological Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio. [illegible] September 30, 1989.

SAGAMORE

Site Description Sheet

QHEI Score: 70

Project No: 00-0681M Stream: Hanna's Creek Date: 9/21/01 Sample Point: 2
Location: Hanna's Creek Conservation Club Crew: Hignite/Manifold

1) SUBSTRATE — SCORE: 16

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)	X	X	**Gravel (7)**	X	X
Boulder (9)		X	**Sand (6)**	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)		X	Detritus (3)	X	X
Muck (2)			Artificial (0)		

SUBSTRATE QUALITY (Check one in each)

Silt Cover
- [ ] - Heavy (-2)
- [ ] - Moderate (-1)
- [x] - Normal (0)
- [ ] - Silt Free (1)

Substrate Origin
- [ ] - Limestone (1)
- [x] - Till (1)
- [ ] - Rip Rap (0)
- [ ] - Hardpan (0)
- [ ] - Sandstone (0)
- [ ] - Shale (-1)
- [ ] - Coal Fines (-2)

Extent of Embeddedness
- [ ] - Extensive (-2)
- [ ] - Moderate (-1)
- [x] - Low (0)
- [ ] - None (1)

TOTAL NUMBER OF SUBSTRATE TYPES
Note: **Ignore** sludge that originates from point-sources.
Score is based on natural substrates
- [ ] - >4 (2)
- [ ] - <= 4 (0)

Comments: ______

2) INSTREAM COVER — SCORE: 15

TYPE
- [ ] - Undercut Banks (1)
- [ ] - Overhanging Vegetation (1)
- [ ] - Shallows (in slow water) (1)
- [ ] - Deep Pools (2)
- [ ] - Rootwads (1)
- [ ] - Boulders (1)
- [ ] - Oxbows (1)
- [x] - Aquatic Macrophytes (1)
- [ ] - Logs or Woody Debris (1)

AMOUNT*
- [ ] - Extensive > 75% (11)
- [ ] - Moderate 25-75% (7)
- [ ] - Sparse 5-25% (3)
- [ ] - Nearly absent < 5% (1)

* Check one or average two

Comments: ______

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 16

SINUOSITY
- [ ] - High (4)
- [ ] - Moderate (3)
- [ ] - Low (2)
- [ ] - None (1)

DEVELOPMENT
- [ ] - Excellent (7)
- [x] - Good (5)
- [ ] - Fair (3)
- [ ] - Poor (1)

CHANNELIZATION
- [x] - None (6)
- [ ] - Recovered (4)
- [ ] - Recovering (3)
- [ ] - Recent or No Recovery

STABILITY
- [ ] - High (3)
- [ ] - Moderate (2)
- [ ] - Low (1)

MODIFICATIONS/OTHER
- [ ] - Snagging
- [ ] - Relocation
- [ ] - Canopy Removal
- [ ] - Dredging
- [ ] - One Side Channel Modifications
- [ ] - Impound
- [ ] - Islands
- [ ] - Levees
- [ ] - Bank-shaping

Comments: ______

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 9

RIPARIAN WIDTH
L R (Per Bank)
- [ ] - Wide > 165 ft. (4)
- [ ] - Moderate 33-165 ft. (3)
- [ ] - Narrow 17-33 ft. (2)
- [ ] - Very Narrow 3-17 ft. (1)
- [ ] - None (0)

EROSION RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
- [ ] - Forest, Swamp (3)
- [ ] - Open Pasture/Row Crop (0)
- [ ] - Residence, Park, New Field (1)
- [ ] - Fenced Pasture (1)

L R (Per Bank)
- [ ] - Urban/Industrial (0)
- [ ] - Shrub/Fallow Field (2)
- [ ] - Conservation Tillage (1)
- [ ] - Mining/Construction (0)

BANK EROSION
L R
- [ ] - None/Little (3)
- [ ] - Moderate (2)
- [ ] - Heavy or Severe (1)

Comments: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 6

MAX. DEPTH (Check one)
- [ ] - >3' (6)
- [ ] - 2'4" - 3' (4)
- [ ] - 1'4" - 2'4" (2)
- [ ] - <1'4" (1)
- [ ] - <0.2m (Pool = 0)

MORPHOLOGY (Check one)
- [ ] - Pool Width > Riffle Width (2)
- [ ] - Pool Width = Riffle Width (1)
- [x] - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all the apply)
- [ ] - Intermittent (-2)
- [x] - Interstitial (-1)
- [ ] - Torrential (-1)
- [ ] - Fast (1)
- [x] - Eddies (1)
- [x] - Moderate (1)
- [ ] - Slow (0)
- [ ] - No Pool (0)

Comments: ______

RIFFLE/RUN DEPTH
- [ ] - Generally >4", Max >2'8" (4)
- [x] - Generally >4", Max <2'8" (3)
- [ ] - Generally 2" - 4" (1)
- [ ] - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
- [ ] - Stable (e.g., Cobble, Boulder) (2)
- [ ] - Mod. Stable (e.g., Pea Gravel) (1)
- [x] - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
- [ ] - Extensive (-1)
- [x] - Low (1)
- [ ] - No Riffle (0)
- [ ] - Moderate (0)
- [ ] - None (2)

Comments: ______

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 49.6 **Average Stream Width:** 30.2' **Drainage Area (sq. miles)** 23.27
% Pool: 10 **%Riffle:** 10 **%Run:** 80

Based on criteria set forth in *Biological Criteria for Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities.* Form ... EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio. First Update September 30, 1989

SAGAMORE

Site Description Sheet

QHEI Score: 67

Project No: 00-0681M Stream: Hanna's Creek Date: 9/21/01 Sample Point: 3
Location: Fosdick Road Crew: Hignite/Manifold

1) SUBSTRATE — SCORE: 19

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)		X	Gravel (7)		X
Boulder (9)		X	Sand (6)		X
Cobble (8)		X	Bedrock (5)		
Hardpan (4)			Detritus (3)		X
Muck (2)			Artificial (0)		X

SUBSTRATE QUALITY (Check one in each)

Silt Cover
- ☐ - Heavy (-2)
- ☐ - Moderate (-1)
- ☐ - Normal (0)
- ☒ - Silt Free (1)

Substrate Origin
- ☐ - Limestone (1)
- ☒ - Till (1)
- ☐ - Rip Rap (0)
- ☐ - Hardpan (0)
- ☐ - Sandstone (0)
- ☐ - Shale (-1)
- ☐ - Coal Fines (-2)

TOTAL NUMBER OF SUBSTRATE TYPES
Note: ignore sludge that originates from point-sources,
Score is based on natural substrates
- ☒ - >4 (2)
- ☐ - </= 4 (0)

Extent of Embeddedness
- ☐ - Extensive (-2)
- ☒ - Low (0)
- ☐ - Moderate (-1)
- ☐ - None (1)

Comments: ______

2) INSTREAM COVER — SCORE: 17

TYPE
- ☒ - Undercut Banks (1)
- ☒ - Overhanging Vegetation (1)
- ☒ - Shallows (in slow water) (1)
- ☐ - Deep Pools (2)
- ☒ - Rootwads (1)
- ☒ - Boulders (1)
- ☐ - Oxbows (1)
- ☒ - Aquatic Macrophytes (1)
- ☐ - Logs or Woody Debris (1)

AMOUNT*
- ☒ - Extensive > 75% (11)
- ☐ - Moderate 25-75% (7)
- ☐ - Sparse 5-25% (3)
- ☐ - Nearly Absent < 5% (1)

* Check one or average two

Comments: ______

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 10

SINUOSITY
- ☐ - High (4)
- ☐ - Moderate (3)
- ☒ - Low (2)
- ☐ - None (1)

DEVELOPMENT
- ☐ - Excellent (7)
- ☐ - Good (5)
- ☒ - Fair (3)
- ☐ - Poor (1)

CHANNELIZATION
- ☐ - None (6)
- ☐ - Recovered (4)
- ☒ - Recovering (3)
- ☐ - Recent or No Recovery

STABILITY
- ☐ - High (3)
- ☒ - Moderate (2)
- ☐ - Low (1)

MODIFICATIONS/OTHER
- ☐ - Snagging
- ☐ - Relocation
- ☐ - Canopy Removal
- ☐ - Dredging
- ☐ - One Side Channel Modifications
- ☐ - Impound
- ☒ - Islands
- ☐ - Leveed
- ☐ - Bank-shaping

Comments: ______

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 6

RIPARIAN WIDTH (L R Per Bank)
- ☐☐ - Wide > 165 ft (4)
- ☐☐ - Moderate 33-165 ft (3)
- ☐☐ - Narrow 17-33 ft (2)
- ☒☒ - Very Narrow 3-17 ft (1)
- ☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY (L R Most Predominant Per Bank)
- ☒☒ - Forest, Swamp (3)
- ☐☐ - Open Pasture/Row Crop (0)
- ☐☐ - Residence, Park, New Field (1)
- ☐☐ - Fenced Pasture (1)

(L R Per Bank)
- ☐☐ - Urban/Industrial (0)
- ☐☐ - Shrub/Fallow Field (2)
- ☐☐ - Conservation Tillage (1)
- ☐☐ - Mining/Construction (0)

BANK EROSION (L R)
- ☐☐ - None/Little (3)
- ☒☒ - Moderate (2)
- ☐☐ - Heavy or Severe (1)

Comments: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 7

MAX. DEPTH (Check one)
- ☐ - >3' (6)
- ☐ - 2' 4" - 3' (4)
- ☒ - 1' 4" - 2' 4" (2)
- ☐ - < 1' 4" (1)
- ☐ - <0.2m (Pool = 0)

MORPHOLOGY (Check one)
- ☐ - Pool Width > Riffle Width (2)
- ☐ - Pool Width = Riffle Width (1)
- ☒ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that apply)
- ☐ - Intermittent (-2)
- ☒ - Interstitial (-1)
- ☐ - Torrential (-1)
- ☐ - Fast (1)
- ☐ - Eddies (1)
- ☒ - Moderate (1)
- ☐ - Slow (0)
- ☒ - No Pool (0)

Comments: ______

RIFFLE/RUN DEPTH
- ☐ - Generally >4", Max >2' 8" (4)
- ☒ - Generally >4", Max < 2' 8" (3)
- ☐ - Generally 2" - 4" (1)
- ☐ - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
- ☐ - Stable (e.g., Cobble, Boulder) (2)
- ☐ - Mod. Stable (e.g., Pea Gravel) (1)
- ☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
- ☐ - Extensive (-1)
- ☐ - Low (1)
- ☐ - No Riffle (0)
- ☒ - Moderate (0)
- ☐ - None (2)

Comments: ______

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 31.3 Average Stream Width: 34.23' Drainage Area (sq. miles): 18.53
% Pool: 0 %Riffle: 40 %Run: 60

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form 1-4-19, EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio. First Update September 30, 1989.

SAGAMORE

Site Description Sheet

QHEI Score: 77

Project No: 00-0681M Stream: Hanna's Creek Date: 9/21/01 Sample Point: 4

Location: Greenwood Road Crew: Hignite/Manifold

1) SUBSTRATE — SCORE: 17

TYPE	Pool	Riffle	TYPE	Pool	Riffle
Boulder/Slabs (10)			Gravel (7)	X	X
Boulder (9)		X	Sand (6)	X	X
Cobble (8)		X	Bedrock (5)		
Hardpan (4)			Detritus (3)	X	X
Muck (2)			Artificial (0)		

SUBSTRATE QUALITY Check one in each.

Silt Cover: ☐ - Heavy (-2) ☐ - Moderate (-1) ☐ - Normal (0) ☐ - Silt Free (1)

Substrate Origin: ☐ - Limestone (1) ☑ - Till (1) ☐ - Rip Rap (0) ☐ - Hardpan (0) ☐ - Sandstone (0) ☐ - Shale (-1) ☐ - Coal Fines (-2)

TOTAL NUMBER OF SUBSTRATE TYPES

Note: Ignore sludge that originates from point-sources. Score is based on natural substrates.

☑ - >4 (2) ☐ - <= 4 (0)

Extent of Embeddedness: ☐ - Extensive (-2) ☐ - Moderate (-1) ☐ - Low (0) ☑ - None (1)

Comments:

2) INSTREAM COVER — SCORE: 16

TYPE

☐ - Undercut Banks (1) ☐ - Overhanging Vegetation (1) ☑ - Shallows (in slow water) (1) ☑ - Deep Pools (2) ☐ - Rootwads (1) ☐ - Boulders (1) ☐ - Oxbows (1) ☑ - Aquatic Macrophytes (1) ☐ - Logs or Woody Debris (1)

AMOUNT*

☑ - Extensive > 75% (11) ☐ - Moderate 25-75% (7) ☐ - Sparse 5-25% (3) ☐ - Nearly Absent < 5% (1)

* Check one or average two

Comments:

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 16

SINUOSITY: ☐ - High (4) ☐ - Moderate (3) ☐ - Low (2) ☐ - None (1)

DEVELOPMENT: ☐ - Excellent (7) ☑ - Good (5) ☐ - Fair (3) ☐ - Poor (1)

CHANNELIZATION: ☐ - None (6) ☐ - Recovered (4) ☐ - Recovering (3) ☐ - Recent or No Recovery

STABILITY: ☐ - High (3) ☑ - Moderate (2) ☐ - Low (1)

MODIFICATIONS/OTHER: ☐ - Snagging ☐ - Relocation ☐ - Canopy Removal ☐ - Dredging ☐ - One Side Channel Modifications ☐ - Impound ☐ - Islands ☐ - Leveed ☐ - Bank-shaping

Comments:

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 9

RIPARIAN WIDTH (L R Per Bank): ☐☐ - Wide > 165 ft. (4) ☐☐ - Moderate 33-165 ft. (3) ☐☐ - Narrow 17-33 ft. (2) ☐☐ - Very Narrow 1-17 ft. (1) ☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY (L R Most Predominant Per Bank): ☐☐ - Forest, Swamp (3) ☐☐ - Open Pasture/Row Crop (0) ☐☐ - Residence, Park, New Field (1) ☐☐ - Fenced Pasture (1)

(L R Per Bank): ☐☐ - Urban/Industrial (0) ☐☐ - Shrub Fallow Field (2) ☐☐ - Conservation Tillage (1) ☐☐ - Mining/Construction (0)

BANK EROSION (L R): ☐☐ - None/Little (3) ☐☐ - Moderate (2) ☐☐ - Heavy or Severe (1)

Comments:

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 11

MAX. DEPTH (Check one): ☐ - >3' (6) ☐ - 2.4' - 3' (4) ☐ - 1.4' - 2.4' (2) ☐ - < 1.4' (1) ☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one): ☐ - Pool Width > Riffle Width (2) ☐ - Pool Width = Riffle Width (1) ☑ - Pool Width < Riffle Width (0)

POOL RUN/RIFFLE CURRENT VELOCITY (Check all that apply): ☐ - Intermittent (-2) ☑ - Interstitial (-1) ☐ - Torrential (-1) ☑ - Fast (1) ☐ - Eddies (1) ☐ - Moderate (1) ☐ - Slow (0) ☐ - No Pool (0)

Comments:

RIFFLE/RUN DEPTH: ☐ - Generally >4", Max >2.8" (4) ☑ - Generally >4", Max <2.8" (3) ☐ - Generally 2" - 4" (1) ☐ - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE: ☐ - Stable (e.g., Cobble, Boulder) (2) ☑ - Mod. Stable (e.g., Pea Gravel) (1) ☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS: ☐ - Extensive (-1) ☐ - Low (1) ☐ - No Riffle (0) ☐ - Moderate (0) ☑ - None (2)

Comments:

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 33.3 Average Stream Width: 17' Drainage Area (sq. miles): 10.81

% Pool: 10 %Riffle: 30 %Run: 60

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form 4410, EPA 4520, Procedure No. WQBS-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio. First Update September 30, 1989.

SAGAMORE

Site Description Sheet

QHEI Score: 72

Project No: 00-0681M Stream: Hanna's Creek Date: 9/21/01 Sample Point: 5
Location: Kitchell Road Crew: Hignite/Manifold

1) SUBSTRATE — SCORE: 17

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)			**Gravel (7)**	X	X
Boulder (9)			**Sand (6)**	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)			Detritus (3)	X	X
Muck (2)			Artificial (0)	X	

TOTAL NUMBER OF SUBSTRATE TYPES
Note: Ignore sludge that originates from point-sources. Score is based on natural substrates
☒ - >4 (2) ☐ - <= 4 (0)

SUBSTRATE QUALITY (Check one in each)

Silt Cover
☐ - Heavy (-2)
☐ - Moderate (-1)
☒ - Normal (0)
☐ - Silt Free (1)

Substrate Origin
☐ - Limestone (1)
☒ - Till (1)
☐ - Rip Rap (0)
☐ - Hardpan (0)
☐ - Sandstone (0)
☐ - Shale (-1)
☐ - Coal Fines (-2)

Extent of Embeddedness
☐ - Extensive (-2)
☐ - Low (0)
☐ - Moderate (-1)
☒ - None (1)

Comments: ______

2) INSTREAM COVER — SCORE: 16

TYPE
☐ - Undercut Banks (1)
☒ - Overhanging Vegetation (1)
☐ - Shallows (in slow water) (1)
☐ - Deep Pools (2)
☒ - Rootwads (1)
☐ - Boulders (1)
☐ - Oxbows (1)
☒ - Aquatic Macrophytes (1)
☒ - Logs or Woody Debris (1)

AMOUNT*
☐ - Extensive >75% (11)
☐ - Moderate 25-75% (7)
☐ - Sparse 5-25% (3)
☐ - Nearly Absent <5% (1)
* Check one or average two

Comments: ______

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 12

SINUOSITY
☐ - High (4)
☐ - Moderate (3)
☒ - Low (2)
☐ - None (1)

DEVELOPMENT
☐ - Excellent (7)
☐ - Good (5)
☐ - Fair (3)
☐ - Poor (1)

CHANNELIZATION
☐ - None (6)
☐ - Recovered (4)
☒ - Recovering (3)
☐ - Recent or No Recovery

STABILITY
☐ - High (3)
☒ - Moderate (2)
☐ - Low (1)

MODIFICATIONS/OTHER
☐ - Snagging
☐ - Relocation
☐ - Canopy Removal
☐ - Dredging
☒ - One Side Channel Modifications
☐ - Impound
☐ - Islands
☐ - Leveed
☒ - Bank-shaping

Comments: ______

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 8

RIPARIAN WIDTH
L R (Per Bank)
☐☐ - Wide >165 ft. (4)
☒☐ - Moderate 33-165 ft. (3)
☐☐ - Narrow 17-33 ft. (2)
☐☒ - Very Narrow 3-17 ft. (1)
☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
☐☐ - Forest, Swamp (3)
☐☐ - Open Pasture/Row Crop (0)
☐☐ - Residence, Park, New Field (1)
☐☐ - Fenced Pasture (1)

L R (Per Bank)
☐☐ - Urban/Industrial (0)
☐☐ - Shrub/Fallow Field (2)
☐☐ - Conservation Tillage (1)
☐☐ - Mining/Construction (0)

BANK EROSION
L R
☐☒ - None/Little (3)
☐☐ - Moderate (2)
☐☐ - Heavy or Severe (1)

Comments. ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 11

MAX. DEPTH (Check one)
☐ - > 1m (6)
☒ - 2' 4" - 3' (4)
☐ - 1' 4" - 2' 4" (2)
☐ - < 1' 4" (1)
☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
☐ - Pool Width > Riffle Width (2)
☒ - Pool Width = Riffle Width (1)
☐ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all the apply)
☐ - Intermittent (-2)
☒ - Interstitial (-1)
☐ - Torrential (-1)
☒ - Fast (1)
☐ - Eddies (1)
☒ - Moderate (1)
☐ - Slow (0)
☒ - No Pool (0)

Comments: ______

RIFFLE/RUN DEPTH
☐ - Generally >4", Max >2' 8" (4)
☐ - Generally >4", Max <2' 8" (3)
☐ - Generally 2" - 4" (1)
☐ - Generally < 2" Riffle = 0)

RIFFLE/RUN SUBSTRATE
☐ - Stable (e.g., Cobble, Boulder) (2)
☒ - Mod. Stable (e.g., Pea Gravel) (1)
☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
☐ - Extensive (-1)
☒ - Low (1)
☐ - No Riffle (0)
☐ - Moderate (0)
☐ - None (2)

Comments: ______

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 33.3 Average Stream Width: 11' Drainage Area (sq. miles): 2.46
% Pool: 20 %Riffle: 15 %Run: 75

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form [illegible], Procedure No. WQPA-SWS-3, State of Ohio Environmental Protection Agency, [illegible] Assessment Section, Division of Water Quality Planning and Assessment, Columbus, Ohio. [illegible]

SAGAMORE

Site Description Sheet   QHEI Score: 54

Project No: 00-0681M Stream: Silver Creek   Date: 9/21/01   Sample Point: 6

Location: Silver Creek Outflow   Crew: Shadley/Rohm

1) SUBSTRATE — SCORE: 10

TYPE	Pool	Riffle		Pool	Riffle
Boulder Slabs (10)			Gravel (7)	X	
Boulder (9)			Sand (6)	X	
Cobble (8)			Bedrock (5)		
Hardpan (4)			Detritus (3)	X	
Muck (2)	X		Artificial (0)		

SUBSTRATE QUALITY (Check one in each)

Silt Cover
- ☒ - Heavy (-2)
- ☐ - Moderate (-1)
- ☐ - Normal (0)
- ☐ - Silt Free (1)

Substrate Origin
- ☐ - Limestone (1)
- ☒ - Till (1)
- ☐ - Rip Rap (0)
- ☐ - Hardpan (0)
- ☐ - Sandstone (0)
- ☐ - Shale (-1)
- ☐ - Coal Fines (-2)

TOTAL NUMBER OF SUBSTRATE TYPES

Note: Ignore sludge that originates from pointsources. Score is based on natural substrates

- ☒ - > 4 (2)
- ☐ - <= 4 (0)

Extent of Embeddedness
- ☐ - Extensive (-2)
- ☐ - Moderate (-1)
- ☐ - Low (0)
- ☒ - None (1)

Comments: Extreme silt impact

2) INSTREAM COVER — SCORE: 11

TYPE
- ☐ - Undercut Banks (1)
- ☒ - Overhanging Vegetation (1)
- ☒ - Shallows (in slow water) (1)
- ☐ - Deep Pools (2)
- ☒ - Rootwads (1)
- ☐ - Boulders (1)
- ☐ - Oxbows (1)
- ☐ - Aquatic Macrophytes (1)
- ☒ - Logs or Woody Debris (1)

AMOUNT*
- ☐ - Extensive > 75% (11)
- ☐ - Moderate 25-75% (7)
- ☐ - Sparse 5-25% (3)
- ☐ - Nearly Absent < 5% (1)

* Check one or average two

Comments:

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 11

SINUOSITY
- ☐ - High (4)
- ☐ - Moderate (3)
- ☒ - Low (2)
- ☐ - None (1)

DEVELOPMENT
- ☐ - Excellent (7)
- ☐ - Good (5)
- ☐ - Fair (3)
- ☐ - Poor (1)

CHANNELIZATION
- ☐ - None (6)
- ☐ - Recovered (4)
- ☐ - Recovering (3)
- ☐ - Recent or No Recovery

STABILITY
- ☐ - High (3)
- ☒ - Moderate (2)
- ☐ - Low (1)

MODIFICATIONS/OTHER
- ☐ - Snagging
- ☐ - Relocation
- ☐ - Canopy Removal
- ☐ - Dredging
- ☐ - One Side Channel Modifications
- ☐ - Impound
- ☐ - Islands
- ☐ - Leveed
- ☐ - Bank-shaping

Comments:

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 10

RIPARIAN WIDTH
L R (Per Bank)
- ☐☐ - Wide > 165 ft. (4)
- ☐☐ - Moderate 33-165 ft. (3)
- ☐☐ - Narrow 17-33 ft. (2)
- ☐☐ - Very Narrow 3-17 ft. (1)
- ☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
- ☒☒ - Forest, Swamp (3)
- ☐☐ - Open Pasture/Row Crop (0)
- ☐☐ - Residence, Park, New Field (1)
- ☐☐ - Fenced Pasture (1)

L R (Per Bank)
- ☐☐ - Urban/Industrial (0)
- ☐☐ - Shrub/Fallow Field (2)
- ☐☐ - Conservation Tillage (1)
- ☐☐ - Mining/Construction (0)

BANK EROSION
L R
- ☒☒ - None/Little (3)
- ☐☐ - Moderate (2)
- ☐☐ - Heavy or Severe (1)

Comments: Erosion at horse path high silt

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 4

MAX. DEPTH (Check one)
- ☐ - > 3' (6)
- ☐ - 2'4" - 3' (4)
- ☒ - 1'4" - 2'4" (2)
- ☐ - < 1'4" (1)
- ☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
- ☐ - Pool Width > Riffle Width (2)
- ☐ - Pool Width = Riffle Width (1)
- ☐ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all the apply)
- ☐ - Intermittent (-2)
- ☐ - Interstitial (-1)
- ☐ - Torrential (-1)
- ☐ - Fast (1)
- ☐ - Eddies (1)
- ☐ - Moderate (1)
- ☐ - Slow (1)
- ☐ - No Pool (0)

Comments: No riffle

RIFFLE/RUN DEPTH
- ☐ - Generally > 4", Max > 2'8" (4)
- ☐ - Generally > 4", Max < 2'8" (3)
- ☐ - Generally 2" - 4" (1)
- ☐ - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
- ☐ - Stable (e.g., Cobble, Boulder) (2)
- ☐ - Mod. Stable (e.g., Pea Gravel) (1)
- ☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
- ☐ - Extensive (-1)
- ☐ - Low (1)
- ☐ - No Riffle (0)
- ☐ - Moderate (0)
- ☐ - None (2)

Comments:

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 29.0   Average Stream Width: 41   Drainage Area (sq. miles): 15.34

% Pool: 100   %Riffle: 0   %Run: 0

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life, Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form [illegible], EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, [illegible] Assessment Section, Division of Water Quality, Planning and Assessment, Columbus, Ohio. Last Update, September 30, 1989.

SAGAMORE

Site Description Sheet

QHEI Score: 70

Project No: 00-0681M Stream: Silver Creek Date: 9/21/01 Sample Point: 7
Location: Snake Hill Road Bridge Crew: Shadley/Rohm

1) SUBSTRATE — SCORE: 17

TYPE

Type	Pool	Riffle	Type	Pool	Riffle
Boulder/Slabs (10)	X		Gravel (7)	X	X
Boulder (9)	X	X	Sand (6)	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)	X		Detritus (3)		
Muck (2)			Artificial (0)		

TOTAL NUMBER OF SUBSTRATE TYPES
Note: Ignore sludge that originates from point-sources; Score is based on natural substrates
[x] - >4 (2) [ ] - <= 4 (0)

SUBSTRATE QUALITY (Check one in each)

Silt Cover
[ ] - Heavy (-2)
[ ] - Moderate (-1)
[x] - Normal (0)
[ ] - Silt Free (1)

Substrate Origin
[ ] - Limestone (1)
[x] - Till (1)
[ ] - Rip Rap (0)
[ ] - Hardpan (0)
[ ] - Sandstone (0)
[ ] - Shale (-1)
[ ] - Coal Fines (-2)

Extent of Embeddedness
[ ] - Extensive (-2) [ ] - Moderate (-1)
[ ] - Low (0) [ ] - None (1)

Comments: ______

2) INSTREAM COVER — SCORE: 11

TYPE
[x] - Undercut Banks (1)
[x] - Overhanging Vegetation (1)
[ ] - Shallows (in slow water) (1)
[ ] - Deep Pools (2)
[ ] - Rootwads (1)
[x] - Boulders (1)
[ ] - Oxbows (1)
[x] - Aquatic Macrophytes (1)
[ ] - Logs or Woody Debris (1)

AMOUNT*
[ ] - Extensive > 75% (11)
[x] - Moderate 25-75% (7)
[ ] - Sparse 5-25% (3)
[ ] - Nearly Absent < 5% (1)
* Check one or average two

Comments: ______

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 15

SINUOSITY
[ ] - High (4)
[ ] - Moderate (3)
[ ] - Low (2)
[ ] - None (1)

DEVELOPMENT
[ ] - Excellent (7)
[x] - Good (5)
[ ] - Fair (3)
[ ] - Poor (1)

CHANNELIZATION
[x] - None (6)
[ ] - Recovered (4)
[ ] - Recovering (3)
[ ] - Recent or No Recovery

STABILITY
[ ] - High (3)
[ ] - Moderate (2)
[x] - Low (1)

MODIFICATIONS/OTHER
[ ] - Snagging [ ] - Impound
[ ] - Relocation [ ] - Islands
[ ] - Canopy Removal [ ] - Leveed
[ ] - Dredging [ ] - Bank-shaping
[ ] - One Side Channel Modifications

Comments: ______

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 8

RIPARIAN WIDTH
L R (Per Bank)
[ ][ ] - Wide > 165 ft (4)
[ ][ ] - Moderate 33-165 ft. (3)
[ ][ ] - Narrow 17-33 ft. (2)
[ ][ ] - Very Narrow 3-17 ft. (1)
[ ][ ] - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R Most Predominant Per Bank
[ ][ ] - Forest, Swamp (3)
[ ][ ] - Open Pasture/Row Crop (0)
[ ][ ] - Residence, Park, New Field (1)
[ ][ ] - Fenced Pasture (1)

L R (Per Bank)
[ ][ ] - Urban/Industrial (0)
[ ][ ] - Shrub/Fallow Field (2)
[ ][ ] - Conservation Tillage (1)
[ ][ ] - Mining/Construction (0)

BANK EROSION
L R
[ ][ ] - None/Little (3)
[ ][ ] - Moderate (2)
[ ][ ] - Heavy or Severe (1)

Comments: ______

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 11

MAX. DEPTH (Check one)
[ ] - > 3' (6)
[ ] - 2' 4" - 3' (4)
[x] - 1' 4" - 2' 4" (2)
[ ] - < 1' 4" (1)
[ ] - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
[ ] - Pool Width > Riffle Width (2)
[x] - Pool Width = Riffle Width (1)
[ ] - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that apply)
[ ] - Intermittent (-2)
[ ] - Interstitial (-1)
[ ] - Torrential (-1)
[x] - Fast (1)
[ ] - Eddies (1)
[x] - Moderate (1)
[x] - Slow (0)
[ ] - No Pool (0)

Comments: ______

RIFFLE/RUN DEPTH
[ ] - Generally >4", Max > 2' 8" (4)
[x] - Generally >4", Max < 2' 8" (3)
[ ] - Generally 2" - 4" (1)
[ ] - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
[x] - Stable (e.g., Cobble, Boulder) (2)
[ ] - Mod. Stable (e.g., Pea Gravel) (1)
[ ] - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
[ ] - Extensive (-1) [ ] - Moderate (0)
[x] - Low (1) [ ] - None (2)
[ ] - No Riffle (0)

Comments: ______

6) GRADIENT — SCORE: 8

Gradient (feet/mile): 29.3 Average Stream Width: 16 Drainage Area (sq. miles): [illegible]
% Pool: 0 %Riffle: 40 %Run: 60

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form Y-4-19, EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality, Planning and Assessment, Columbus, Ohio. First Update September 30, 1989

SAGAMORE

Site Description Sheet

QHEI Score: 79

Project No: 00-0681M Stream: Silver Creek Date: 9/21/01 Sample Point: 8

Location: Old US 27 Crew: Shadley/Rohm

1) SUBSTRATE — SCORE: 16

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)	X		Gravel (7)	X	X
Boulder (9)	X	X	Sand (6)	X	X
Cobble (8)	X	X	Bedrock (5)	X	
Hardpan (4)	X		Detritus (3)		
Muck (2)			Artificial (0)		

SUBSTRATE QUALITY (Check one in each)

Silt Cover
- ☐ - Heavy (-2)
- ☐ - Moderate (-1)
- ☒ - Normal (0)
- ☐ - Silt Free (1)

Substrate Origin
- ☐ - Limestone (1)
- ☒ - Till (1)
- ☐ - Rip Rap (0)
- ☐ - Hardpan (0)
- ☐ - Sandstone (0)
- ☐ - Shale (-1)
- ☐ - Coal Fines (-2)

TOTAL NUMBER OF SUBSTRATE TYPES

Note: ignore sludge that originates from point-sources.
Score is based on natural substrates

- ☒ - >4 (2)
- ☐ - <= 4 (0)

Extent of Embeddedness
- ☐ - Extensive (-2)
- ☐ - Moderate (-1)
- ☒ - Low (0)
- ☐ - None (1)

Comments: ____

2) INSTREAM COVER — SCORE: 16

TYPE
- ☐ - Undercut Banks (1)
- ☐ - Overhanging Vegetation (1)
- ☐ - Shallows (in slow water) (1)
- ☐ - Deep Pools (2)
- ☐ - Rootwads (1)
- ☐ - Boulders (1)
- ☐ - Oxbows (1)
- ☒ - Aquatic Macrophytes (1)
- ☐ - Logs or Woody Debris (1)

AMOUNT*
- ☐ - Extensive > 75% (11)
- ☐ - Moderate 25-75% (7)
- ☐ - Sparse 5-25% (3)
- ☐ - Nearly Absent < 5% (1)

* Check one or average two

Comments: ____

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 15

SINUOSITY
- ☐ - High (4)
- ☒ - Moderate (3)
- ☐ - Low (2)
- ☐ - None (1)

DEVELOPMENT
- ☐ - Excellent (7)
- ☐ - Good (5)
- ☐ - Fair (3)
- ☐ - Poor (1)

CHANNELIZATION
- ☐ - None (6)
- ☐ - Recovered (4)
- ☐ - Recovering (3)
- ☐ - Recent or No Recovery

STABILITY
- ☐ - High (3)
- ☐ - Moderate (2)
- ☐ - Low (1)

MODIFICATIONS/OTHER
- ☐ - Snagging
- ☐ - Relocation
- ☐ - Canopy Removal
- ☐ - Dredging
- ☐ - One Side Channel Modifications
- ☐ - Impound
- ☐ - Islands
- ☐ - Leveed
- ☐ - Bankshaping

Comments: ____

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 7

RIPARIAN WIDTH

L R (Per Bank)
- ☐☐ - Wide > 165 ft (4)
- ☐☐ - Moderate 33-165 ft (3)
- ☐☐ - Narrow 17-33 ft (2)
- ☐☐ - Very Narrow 3-17 ft (1)
- ☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY

L R (Most Predominant Per Bank)
- ☐☐ - Forest, Swamp (3)
- ☐☐ - Open Pasture/Row Crop (0)
- ☐☐ - Residence, Park, New Field (1)
- ☐☐ - Fenced Pasture (1)

L R (Per Bank)
- ☐☐ - Urban/Industrial (0)
- ☐☐ - Shrub/Fallow Field (2)
- ☐☐ - Conservation Tillage (1)
- ☐☐ - Mining/Construction (0)

BANK EROSION

L R
- ☐☐ - None/Little (3)
- ☐☐ - Moderate (2)
- ☐☐ - Heavy or Severe (1)

Comments: ____

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 14

MAX. DEPTH (Check one)
- ☐ - >3' (6)
- ☒ - 2' 4" - 3' (4)
- ☐ - 1' 4" - 2' 4" (2)
- ☐ - < 1' 4" (1)
- ☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
- ☐ - Pool Width > Riffle Width (2)
- ☒ - Pool Width = Riffle Width (1)
- ☐ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all the apply)
- ☐ - Intermittent (-2)
- ☐ - Interstitial (-1)
- ☐ - Torrential (-1)
- ☐ - Fast (1)
- ☐ - Eddies (1)
- ☒ - Moderate (1)
- ☒ - Slow (0)
- ☐ - No Pool (0)

Comments: ____

RIFFLE/RUN DEPTH
- ☐ - Generally >4", Max > 2' 8" (4)
- ☐ - Generally >4", Max < 2' 8" (3)
- ☐ - Generally 2" – 4" (1)
- ☐ - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
- ☐ - Stable (e.g., Cobble, Boulder) (2)
- ☐ - Mod. Stable (e.g., Pea Gravel) (1)
- ☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
- ☐ - Extensive (-1)
- ☐ - Low (1)
- ☐ - No Riffle (0)
- ☐ - Moderate (0)
- ☐ - None (2)

Comments: ____

6) GRADIENT — SCORE: 10

Gradient (feet/mile): 26.5 **Average Stream Width:** 18' **Drainage Area (sq. miles):** 6.93

% Pool: 20 **%Riffle:** 50 **%Run:** 50

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form V-4-19, EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality, Planning and Assessment, Columbus, Ohio. First Update September 30, 1989

SAGAMORE

Site Description Sheet

QHEI Score: 71

Project No: 00-0681M Stream: Silver Creek Date: 9/21/01 Sample Point: 9
Location: Stout Road Bridge Crew: Shadley/Rohm

1) SUBSTRATE — SCORE: 18

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)	X	X	Gravel (7)	X	X
Boulder (9)			Sand (6)	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)			Detritus (3)		
Muck (2)			Artificial (0)		

TOTAL NUMBER OF SUBSTRATE TYPES
Note: ignore sludge that originates from point-sources.
Score is based on natural substrates
☒ - > 4 (2) ☐ - < = 4 (0)

SUBSTRATE QUALITY (Check one in each)

Silt Cover
☐ - Heavy (-2)
☐ - Moderate (-1)
☐ - Normal (0)
☐ - Silt Free (1)

Substrate Origin
☐ - Limestone (1)
☐ - Till (1)
☐ - Rip Rap (0)
☐ - Hardpan (0)
☐ - Sandstone (0)
☐ - Shale (-1)
☐ - Coal Fines (-2)

Extent of Embeddedness
☐ - Extensive (-2)
☐ - Moderate (-1)
☐ - Low (0)
☐ - None (1)

Comments:

2) INSTREAM COVER — SCORE: 10

TYPE
☐ - Undercut Banks (1)
☒ - Overhanging Vegetation (1)
☐ - Shallows (in slow water) (1)
☐ - Deep Pools (2)
☐ - Rootwads (1)
☐ - Boulders (1)
☐ - Oxbows (1)
☐ - Aquatic Macrophytes (1)
☐ - Logs or Woody Debris (1)

AMOUNT*
☐ - Extensive > 75% (11)
☐ - Moderate 25-75% (7)
☐ - Sparse 5-25% (3)
☐ - Nearly Absent < 5% (1)
* Check one or average two

Comments:

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 15

SINUOSITY
☐ - High (4)
☐ - Moderate (3)
☐ - Low (2)
☐ - None (1)

DEVELOPMENT
☐ - Excellent (7)
☐ - Good (5)
☐ - Fair (3)
☐ - Poor (1)

CHANNELIZATION
☒ - None (6)
☐ - Recovered (4)
☐ - Recovering (3)
☐ - Recent or No Recovery

STABILITY
☐ - High (3)
☐ - Moderate (2)
☐ - Low (1)

MODIFICATIONS/OTHER
☐ - Snagging
☐ - Relocation
☐ - Canopy Removal
☐ - Dredging
☐ - One Side Channel Modifications
☐ - Impound
☐ - Islands
☐ - Leveed
☐ - Bank-shaping

Comments:

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 7

RIPARIAN WIDTH
L R (Per Bank)
☐☐ - Wide > 165 ft. (4)
☐☐ - Moderate 33-165 ft. (3)
☐☐ - Narrow 17-33 ft. (2)
☐☐ - Very Narrow 3-17 ft. (1)
☐☐ - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
☐☐ - Forest, Swamp (3)
☐☐ - Open Pasture/Row Crop (0)
☐☐ - Residence, Park, New Field (1)
☐☐ - Fenced Pasture (1)

L R (Per Bank)
☐☐ - Urban/Industrial (0)
☐☐ - Shrub/Fallow Field (2)
☐☐ - Conservation Tillage (1)
☐☐ - Mining/Construction (0)

BANK EROSION
L R
☐☐ - None/Little (3)
☐☐ - Moderate (2)
☐☐ - Heavy or Severe (1)

Comments: Large area on right bank that is eroded (very unstable)

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 11

MAX. DEPTH (Check one)
☐ - > 3' (6)
☐ - 2' 4" - 3' (4)
☒ - 1' 4" - 2' 4" (2)
☐ - < 1' 4" (1)
☐ - < 0.2m (Pool = 0)

MORPHOLOGY (Check one)
☒ - Pool Width > Riffle Width (2)
☐ - Pool Width = Riffle Width (1)
☐ - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all the apply)
☐ - Intermittent (-2)
☐ - Interstitial (-1)
☐ - Torrential (-1)
☐ - Fast (1)
☐ - Eddies (1)
☐ - Moderate (1)
☐ - Slow (1)
☐ - No Pool (0)

Comments:

RIFFLE/RUN DEPTH
☐ - Generally > 4", Max > 2' 8" (4)
☐ - Generally > 4", Max < 2' 8" (3)
☐ - Generally 2" - 4" (1)
☐ - Generally < 2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
☐ - Stable (e.g., Cobble, Boulder) (2)
☐ - Mod. Stable (e.g., Pea Gravel) (1)
☐ - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
☐ - Extensive (-1)
☐ - Low (1)
☐ - No Riffle (0)
☐ - Moderate (0)
☐ - None (2)

Comments:

6) GRADIENT — SCORE: 10

Gradient (feet/mile): 23
Average Stream Width: 6'
Drainage Area (sq. miles): 1.37
% Pool: 30
%Riffle: 30
%Run: 40

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form EPA 4520. Procedure No. WQPA-SWS-3. State of Ohio Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality, Planning and Assessment, Columbus, Ohio. First Update: September 30, 1989.

SAGAMORE

Site Description Sheet

QHEI Score: 69

Project No: 00-0681M Stream: Silver Creek Date: 9/21/01 Sample Point: 10
Location: Mitchell Road Bridge Crew: Shadley/Rohm

1) SUBSTRATE — SCORE: 19

TYPE	Pool	Riffle		Pool	Riffle
Boulder/Slabs (10)		X	Gravel (7)	X	X
Boulder (9)			Sand (6)	X	X
Cobble (8)	X	X	Bedrock (5)		
Hardpan (4)			Detritus (3)		
Muck (2)			Artificial (0)		

TOTAL NUMBER OF SUBSTRATE TYPES
Note: Ignore sludge that originates from point-sources. Score is based on natural substrates
[x] - >4 (2) [ ] - <=4 (0)

SUBSTRATE QUALITY (Check one in each)

Silt Cover: [ ] - Heavy (-2) [ ] - Moderate (-1) [x] - Normal (0) [ ] - Silt Free (1)

Substrate Origin: [ ] - Limestone (1) [x] - Till (1) [ ] - Rip Rap (0) [ ] - Hardpan (0) [ ] - Sandstone (0) [ ] - Shale (-1) [ ] - Coal Fines (-2)

Extent of Embeddedness: [ ] - Extensive (-2) [ ] - Moderate (-1) [ ] - Low (0) [x] - None (1)

Comments: ____

2) INSTREAM COVER — SCORE: 11

TYPE
[ ] - Undercut Banks (1) [ ] - Deep Pools (2) [ ] - Oxbows (1)
[x] - Overhanging Vegetation (1) [ ] - Rootwads (1) [x] - Aquatic Macrophytes (1)
[ ] - Shallows (in slow water) (1) [x] - Boulders (1) [ ] - Logs or Woody Debris (1)

AMOUNT*
[ ] - Extensive >75% (11)
[x] - Moderate 25-75% (7)
[ ] - Sparse 5-25% (3)
[ ] - Nearly Absent <5% (1)
* Check one or average two

Comments: ____

3) CHANNEL MORPHOLOGY (Check one per category or average two) — SCORE: 14

SINUOSITY: [ ] - High (4) [ ] - Moderate (3) [x] - Low (2) [ ] - None (1)

DEVELOPMENT: [ ] - Excellent (7) [x] - Good (5) [ ] - Fair (3) [ ] - Poor (1)

CHANNELIZATION: [ ] - None (6) [x] - Recovered (4) [ ] - Recovering (3) [ ] - Recent or No Recovery

STABILITY: [x] - High (3) [ ] - Moderate (2) [ ] - Low (1)

MODIFICATIONS/OTHER: [ ] - Snagging [ ] - Impound [ ] - Relocation [ ] - Islands [ ] - Canopy Removal [ ] - Leveed [ ] - Dredging [ ] - Bank Shaping [ ] - One Side Channel Modifications

Comments: ____

4) RIPARIAN ZONE AND BANK EROSION (Check one per category or average two) — SCORE: 6

RIPARIAN WIDTH
L R (Per Bank)
[ ][ ] - Wide >165 ft. (4)
[ ][ ] - Moderate 33-165 ft. (3)
[ ][ ] - Narrow 17-33 ft. (2)
[x][x] - Very Narrow 3-17 ft. (1)
[ ][ ] - None (0)

EROSION/RUNOFF-FLOODPLAIN QUALITY
L R (Most Predominant Per Bank)
[ ][ ] - Forest, Swamp (3)
[ ][ ] - Open Pasture/Row Crop (0)
[ ][ ] - Residence, Park, New Field (1)
[ ][ ] - Fenced Pasture (1)

L R (Per Bank)
[ ][ ] - Urban/Industrial (0)
[x][x] - Shrub/Fallow Field (2)
[ ][ ] - Conservation Tillage (1)
[ ][ ] - Mining/Construction (0)

BANK EROSION
L R
[ ][ ] - None/Little (3)
[x][x] - Moderate (2)
[ ][ ] - Heavy or Severe (1)

Comments: Some trees are present

5) POOL/GLIDE AND RIFFLE/RUN QUALITY — SCORE: 9

MAX. DEPTH (Check one)
[ ] - >3' (6)
[ ] - 2'4" - 3' (4)
[ ] - 1'4" - 2'4" (2)
[ ] - <1'4" (1)
[ ] - <0.2m (Pool = 0)

MORPHOLOGY (Check one)
[x] - Pool Width > Riffle Width (2)
[ ] - Pool Width = Riffle Width (1)
[ ] - Pool Width < Riffle Width (0)

POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that apply)
[ ] - Intermittent (-2) [ ] - Interstitial (-1) [ ] - Torrential (-1) [x] - Fast (1) [ ] - Eddies (1) [ ] - Moderate (1) [ ] - Slow (1) [ ] - No Pool (0)

Comments: ____

RIFFLE/RUN DEPTH
[ ] - Generally >4", Max >2.8" (4)
[ ] - Generally >4", Max <2.8" (3)
[x] - Generally 2"-4" (1)
[ ] - Generally <2" (Riffle = 0)

RIFFLE/RUN SUBSTRATE
[x] - Stable (e.g., Cobble, Boulder) (2)
[ ] - Mod. Stable (e.g., Pea Gravel) (1)
[ ] - Unstable (e.g., Gravel, Sand) (0)

RIFFLE/RUN EMBEDDEDNESS
[ ] - Extensive (-1) [ ] - Moderate (0) [ ] - Low (1) [x] - None (2) [ ] - No Riffle (0)

Comments: ____

6) GRADIENT — SCORE: 10

Gradient (feet/mile): 15.9 Average Stream Width: 2' Drainage Area (sq. miles): 2.12
% Pool: 75 % Riffle: 25 % Run: 0

Based on criteria set forth in Biological Criteria for Protection of Aquatic Life: Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Form 4/6/89. EPA 4520. Ecological Assessment Section, Division of Water Quality, Planning and Assessment, Columbus, Ohio. First Update: September 30, 1989.

APPENDIX O

Public Handout

Results of Study

Based on the results of the water quality and biological quality assessments, Silver Creek and Hanna's Creek are generally in good condition. When compared to assessments performed on similar streams throughout the region, these creeks fall within the average. However, during storm flow conditions, there are elevated concentrations of compounds associated with fertilizers (phosphorus) and manure/sewage (fecal coliform and organic nitrogen) and sediment in the water. The Indiana Department of Environmental Management (IDEM) has established maximum concentration limits for water quality standards within surface waters. Analysis of water samples determined that concentrations of fecal coliform, organic nitrogen, phosphorus, and turbidity are not compliant with IDEM standards. These concentrations were significantly above maximum limits for surface water, particularly in Silver Creek.

The majority of aquatic species collected and identified within each stream are not found in polluted waterways. Assessments of stream corridors revealed an abundance of quality habitat.

Monitoring has indicated that both streams drain their respective watersheds quickly. Unfortunately, the receptors of these streams are lakes that provide regional recreation and local economic inflow. Specific sites throughout the creeks have been selected for potential management projects designed to significantly reduce soil runoff and effluent concentrations. The purpose of these management projects is to improve the overall water quality and biological diversity of the watersheds and, simultaneously, Whitewater and Brookville Lakes.

Union County Soil and Water Conservation District
2590 North Park Road
Connersville, Indiana 47331

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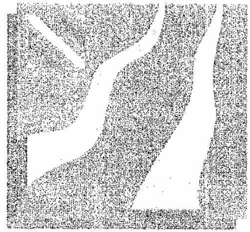
LIFE BETWEEN THE CREEKS



SILVER CREEK & HANNA'S CREEK
Watershed Diagnostic Study

Union County Soil and Water Conservation District

A discussion of the past, current, and potential future of water and habitat quality

Silver Creek & Hanna's Creek Watershed Diagnostic Study

The purpose of a Watershed Diagnostic Study is to:

- Describe condition and trends in selected streams and watersheds
- Identify potential sources of water quality problems
- Prioritize potential land treatment projects
- Propose specific direction for future management
- Predict and assess success factors for future management

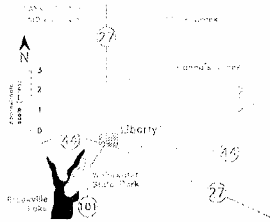
Please contact the Union County Soil and Water Conservation District for more information. (765) 825 - 4311

Watershed?
An area of land from which all water drains to a common outlet.

• THE WATERSHEDS •

The Silver Creek watershed is comprised of approximately 12,340 acres. Approximately 2,000 acres of the Silver Creek watershed are located in Wayne County, Indiana and were not included in this study. A majority of the Town of Liberty, Witt's Station, and a portion of Whitewater State Park are included within this watershed. Silver Creek drains into Whitewater Lake.

The Hanna's Creek watershed is comprised of approximately 22,119 acres. A small portion of the Town of Liberty, Kitchel, a portion of Roseburg, and a portion of the state owned property around the Brookville Lake area are included within the watershed. Hanna's Creek drains into Brookville Lake.



Land Use Summary (approximate acreage)

Land Use	Silver Creek	Hanna's Creek
Agricultural	8,027	18,492
Wooded	1,489	3,570
Golf Course	146	0
Commercial/Industrial	24	0
Mixed	328	48
Residential	307	9
School	19	0

This project was funded as part of the Indiana Department of Natural Resources Lake and River Enhancement Program

RURAL EFFECTS ON THE WATERSHEDS

Agricultural Runoff - Nutrients, in the form of fertilizers and manure, can runoff into the streams. These can be bound to eroded soil if they are not taken-up by crops or held on site by best management practices.

Livestock Operations - Livestock areas that are on the stream or its tributaries can cause soil loss due to lack of binding vegetation. These areas can contribute manure and ammonia to the stream.

URBAN EFFECTS ON THE WATERSHEDS

Residential - Development of residential properties on septic systems can contribute human waste to the watershed. This can occur due to poor design, system breach, and groundwater/surface water interaction.

Wastewater Treatment - Most wastewater treatment facilities, if part of a combined sewer overflow, are permitted to discharge raw sewage during periods of high flow.

Turf Grass Management - Excess fertilizers and pesticides can run off from golf courses and lawns into streams.

Pavement - Impervious surfaces such as roads and parking lots increases runoff by reducing permeability. Constituents associated with automobiles (oil grease, antifreeze, etc.) runoff into streams via storm drains.

Sedimentation of Brookville Lake

The inlet at the discharge point of Hanna's Creek into Brookville Lake is filling with sediment deposited from Hanna's Creek. According to the property management personnel at Brookville Lake, the marina located in this inlet is being compromised due to the sediment accumulation.

Sedimentation of Whitewater Lake

The discharge point of Silver Creek into Whitewater Lake is filling with sediment deposited from Silver Creek. The USGS issued a report in 1993 concerning this issue. According to this report, the annual rate of sediment accumulation in the lake is 357,000 feet^3 per year.

The field work and historic review for this project was performed by Sagamore Environmental Services, Inc. in cooperation with the Union County Soil and Water Conservation District

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

FIELD BORDER

(Feet)

CODE 386

DEFINITION

A strip of permanent vegetation established at the edge or around the perimeter of a field.

PURPOSES

- Reduce erosion from wind and water
- Soil and water quality protection
- Management of harmful insect populations
- Provide wildlife food and cover

CONDITIONS WHERE PRACTICE APPLIES

At the edges of cropland fields and to connect other buffer practices within the field. May also apply to recreation land or other land uses where agronomic crops are grown.

CRITERIA

General Criteria Applicable To All Purposes

Minimum field border widths shall be based on local design criteria specific to the purpose or purposes for installing the practice.

The field borders will be established to adapted species of permanent grass, legumes, and/or shrubs.

Field borders will be established around the field edges to the extent needed to meet the resource needs and producer objectives.

Plant material, seedbed preparation, seeding rates, dates, depths, and planting methods will be consistent with approved local criteria.

Ephemeral gullies and rills present in the planned border area will be smoothed as part of seedbed preparation.

Additional Criteria To Reduce Erosion From Wind And Water

Wind Erosion Reduction

Locate borders around the entire perimeter of the field, or as a minimum, provide a stable area on the upwind edge of the field as determined by prevailing wind direction data.

Plant stiff-stemmed, upright grasses to trap saltating soil particles.

Minimum height of grass shall be one foot during the critical erosion period.

Water Erosion Reduction

Locate borders around entire perimeter of the field, or as a minimum, install borders to eliminate sloping end rows, headlands, and other areas where concentrated water flows will enter or exit the field.

Additional Criteria To Protect Soil And Water Quality

Reducing Runoff and Increasing Infiltration

Locate borders around entire perimeter of the field, or as a minimum, install borders to eliminate sloping end rows, headlands and other areas where concentrated water flows will enter or exit the field.

Maintaining Field Setback Distances For Manure and Chemical Applications

Border widths will be designed to conform to minimum field application setback widths established by state or local regulations.

Sediment Trapping

Locate borders around the entire perimeter of the field, or as a minimum, in areas where runoff enters or leaves the field.

Reducing Soil Compaction from Equipment Parking and Traffic

Border widths will be designed to accommodate equipment parking, loading/unloading equipment, grain harvest operations, etc.

Additional Criteria For Management Of Harmful Insect Populations.

Provide a Harbor For Beneficial Insects

Include herbaceous plants that attract beneficial insects. See planning considerations for including shrubs.

Mowing, harvesting, and pesticide applications will be scheduled to accommodate life cycle requirements of the beneficial insects.

or

Provide a Habitat to Cause Pest Insects to Congregate

Select plants for the field border that attract pest insects.

Use mechanical, cultural, and/or chemical techniques to reduce pest populations when and where they congregate in the field border.

Additional Criteria To Provide Wildlife Food And Cover

Plants that provide wildlife food and cover shall be used.

Mowing, harvest, and weed control activities within the field border will be scheduled to accommodate reproduction and other requirements of target wildlife species.

PLANNING CONSIDERATIONS

Field borders are more effective and provide more environmental benefits when planted around the entire field.

Field borders enhance the aesthetics and provide stability around the field edge. They also provide turn and travel areas for equipment and reduce airborne dust

To increase trapping efficiency, consider establishing a narrow strip of stiff-stemmed upright grass at the crop/field border interface.

Field borders can be used to comply with required field setback distances applicable to manure and chemical applications.

Wildlife enhancement and other benefits of native plants should be discussed during planning.

Native species should be used when feasible and meet producer objectives.

Consider overseeding the border with legumes for plant diversity and wildlife benefits.

Schedule mowing, harvesting, and weed control to accommodate wildlife nesting needs and other special requirements or purposes.

Waterbars or berms may be needed to breakup or redirect concentrated water flows within the borders.

If bank stabilization is a concern, select fibrous deep-rooted plants.

Consider plants tolerant to sediment deposition and chemicals planned for application.

Rows of shrubs (windbreak/shelterbelt, 380) adjacent to field borders will often enhance field borders ability to harbor beneficial insects, and may also provide additional wildlife benefits.

If installation or maintenance of the practice has potential of affecting cultural resources (Archaeological, historic, historic landscape, or traditional cultural properties), follow NRCS state policy for considering cultural resources.

PLANS AND SPECIFICATIONS

Plans and specifications are to be prepared for the practice site. The following items should be specified. A job sheet is available to document these items:

- Border widths and lengths based on local design criteria
- Location within the field or farm boundary
- Vegetation to be used

- Site preparation
- Planting method
- Liming or fertilizer requirements
- Operation and maintenance requirements

OPERATION AND MAINTENANCE

Field borders require careful management and maintenance for performance and longevity.

The following will be planned and applied as needed:

- Storm damage repair.
- Sediment removal - when 6 inches of sediment have accumulated at the field border/cropland interface.
- Shut off sprayers and raise tillage equipment to avoid damage to field borders.
- Shape and reseeding border areas damaged by chemicals, tillage or equipment traffic.
- Fertilize, mow, harvest, and control noxious weeds to maintain plant vigor.
- Ephemeral gullies and rills that develop in the border will be filled and reseeded.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

(Acre)

CODE 412

DEFINITION

A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- to convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- to reduce gully erosion
- to protect/improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff and where such control can be achieved by using this practice alone or combined with other conservation practices.

CRITERIA

General Criteria Applicable to All Purposes

Grassed waterways shall be planned, designed, and constructed to comply with all Federal, State, and local laws and regulations.

Capacity. The minimum capacity shall be that required to convey the peak runoff expected from a storm of 10-year frequency, 24-hour duration. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. The minimum in such cases shall be the capacity required to remove the water before crops are damaged.

Velocity. Design velocities shall not exceed those obtained by using the procedures, "n" values, and recommendations in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-lined Open Channels.

Width. The bottom width of trapezoidal waterways shall not exceed 100 feet unless multiple or divided waterways or other means are provided to control meandering of low flows.

Side slopes. Side slopes shall not be steeper than a ratio of two horizontal to one vertical. They shall be designed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment that will cross the waterway.

Depth. The minimum depth of a waterway that receives water from terraces, diversions, or other tributary channels shall be that required to keep the design water surface elevation at, or below the design water surface elevation in the tributary channel, at their junction when both are flowing at design depth.

Freeboard above the designed depth shall be provided when flow must be contained to prevent damage. Freeboard shall be provided above the designed depth when the vegetation has the maximum expected retardance.

Drainage. Designs for sites having prolonged flows, a high water table, or seepage problems shall include Subsurface Drains (NRCS Practice Code 606), Underground Outlets

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

(NRCS Practice Code 620), Stone Center Waterways or other suitable measures to avoid saturated conditions.

Outlets. All grassed waterways shall have a stable outlet with adequate capacity to prevent ponding or flooding damages. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip or other suitable outlet.

Vegetative Establishment. Grassed waterways shall be vegetated according to NRCS Conservation Practice Standard Critical Area Planting, Code 342.

Seedbed preparation, time of seeding, mixture rate, stabilizing crop, mulching, or mechanical means of stabilizing, fertilizer, and lime requirements shall be specified for each applicable area.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, filter fences, or runoff diversion to protect the vegetation until it is established.

CONSIDERATIONS

Important wildlife habitat, such as woody cover or wetlands, should be avoided or protected if possible when siting the grassed waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Mid- or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands.

Water-tolerant vegetation may be an alternative on some wet sites.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation.

Establish filter strips on each side of the waterway to improve water quality.

Add width of appropriate vegetation to the sides of the waterway for wildlife habitat.

PLANS AND SPECIFICATIONS

Plans and specifications for grassed waterways shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s).

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided to and reviewed with the landowner. The plan shall include the following items and others as appropriate.

A maintenance program shall be established to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.

Seeding shall be protected from concentrated flow and grazing until vegetation is established.

Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods.

Inspect grassed waterways regularly, especially following heavy rains. Damaged areas will be filled, compacted, and seeded immediately. Remove sediment deposits to maintain capacity of grassed waterway.

Landowners should be advised to avoid areas where forbs have been established when applying herbicides. Avoid using waterways as turn-rows during tillage and cultivation operations. Prescribed burning and mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.

Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition.

Control noxious weeds.

Do not use as a field road. Avoid crossing with heavy equipment when wet.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

FILTER STRIP

(ACRES)

CODE 393

DEFINITION

A strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land) and environmentally sensitive areas.

PURPOSE

- To reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in runoff
- To reduce dissolved contaminant loadings in runoff
- To serve as Zone 3 of a Riparian Forest Buffer, Practice Standard 391
- To reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in surface irrigation tailwater
- To restore, create or enhance herbaceous habitat for wildlife and beneficial insects.
- To maintain or enhance watershed functions and values

CONDITIONS WHERE PRACTICE APPLIES

This practice applies (1) in areas situated below cropland, grazing land, or disturbed land (including forest land) (2) where sediment, particulate organic matter and/or dissolved contaminants may leave these areas and are entering environmentally sensitive areas; (3) in areas where permanent vegetative establishment is needed to enhance wildlife and beneficial insects, or maintain or enhance watershed function. This practice applies when planned as part of a conservation management system.

CRITERIA

General criteria applicable to all purposes

Filter strips shall be designated as vegetated areas to treat runoff and are not part of the adjacent cropland rotation.

Overland flow entering the filter strip shall be primarily sheet flow. Concentrated flow shall be dispersed.

State listed noxious weeds will not be established in the filter strip and will be controlled if present.

Filter strip establishment shall comply with local, state and federal regulations.

Additional criteria to reduce sediment, particulate organics, and sediment-adsorbed contaminant loadings in runoff

Filter strip flow length shall be determined based on field slope percent and length, and filter strip slope percent, erosion rate, amount and particle size distribution of sediment delivered to the filter strip, density and height of the filter strip vegetation, and runoff volume associated with erosion producing events. The minimum flow length for this purpose shall be 20 feet.

Filter strip location requirements:

a) The filter strip shall be located along the downslope edge of a field or disturbed area. To the extent practical it shall be placed on the approximate contour. Variation in placement on the contour should not exceed

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

a 0.5% longitudinal (perpendicular to the flow length) gradient.

b) The drainage area above the filter strip shall have greater than 1% but less than 10% slopes.

c) The ratio of the drainage area to the filter strip area shall be less than 70:1 in regions with RUSLE-R factor values 0-35, 60:1 in regions with RUSLE-R factor values 35-175, and 50:1 in regions with RUSLE-R factor values of more than 175.

d) The average annual sheet and rill erosion rate above the filter strip shall be less than 10 tons per acre per year

The filter strip shall be established to permanent herbaceous vegetation consisting of a single species or a mixture of grasses, legumes and/or other forbs adapted to the soil, climate, and nutrients, chemicals, and practices used in the current management system. Species selected shall have stiff stems and a high stem density near the ground surface. Stem density shall be such that the stem spacing does not exceed 1 inch.

Additional criteria to reduce dissolved contaminants in runoff

The criteria given in "Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in runoff" also apply to this purpose.

Filter strip flow length required to reduce dissolved contaminants in runoff shall be based on management objectives, contaminants of concern, and the volume of runoff from the filter strip's drainage area compared with the filter strip's area and infiltration capacity.

The flow length determined for this purpose shall be in addition to the flow length determined for reducing sediment, particulate organics, and sediment-adsorbed contaminant loadings in runoff. The minimum flow length for this purpose shall be 30 feet.

Additional criteria to serve as Zone 3 of a Riparian Forest Buffer, Practice Standard 391

Except for the location requirements, the criteria given in "Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in runoff" also apply to this purpose.

If concentrated flows entering Zone 3 are greater than the filter strip's ability to disperse them, other means of dispersal, such as spreading devices, must be incorporated.

Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loadings in surface irrigation tailwater

Filter strip vegetation may be a small grain or other suitable annual with a plant spacing that does not exceed 4 inches.

Filter strips shall be established early enough prior to the irrigation season so that the vegetation can withstand sediment deposition from the first irrigation.

The flow length shall be based on management objectives.

Additional criteria to restore, create, or enhance herbaceous habitat for wildlife and beneficial insects

If this purpose is intended in combination with one or more of the previous purposes, then the minimum criteria for the previous purpose(s) must be met. Additional filter strip flow length devoted to this purpose must be added to the length required for the other purpose(s).

Any addition to the flow length for wildlife or beneficial insects shall be added to the downhill slope of the filter strip. Vegetation to enhance wildlife may be added to that portion of the filter strip devoted to other purposes to the extent they do not detract from its primary functions.

Plant species selected for this purpose shall be for permanent vegetation adapted to the wildlife or beneficial insect population(s) targeted.

If this is the only purpose, filter strip width and length shall be based on requirements of the targeted wildlife or insects. Density of the vegetative stand established for this purpose shall consider targeted wildlife habitat requirements and encourage plant diversity. Dispersed woody vegetation may be used to the extent it does not interfere with herbaceous vegetative growth, or operation and maintenance of the filter strip.

The filter strip shall not be mowed during the nesting season of the target wildlife.

Livestock and vehicular traffic in the filter strip shall be excluded during the nesting season of the target species.

Additional criteria to maintain or enhance watershed functions and values

Filter strips shall be strategically located to enhance connectivity of corridors and non-cultivated patches of vegetation within the watershed.

Filter strips should be strategically located to enhance aesthetics of the watershed.

Plant species selected for this purpose shall be for establishment of permanent vegetation.

CONSIDERATIONS

Filter strips should be strategically located to reduce runoff, and increase infiltration and ground water recharge throughout the watershed.

Filter strips for the single purposes of wildlife/beneficial insect habitat or to enhance watershed function should be strategically located to intercept contaminants thereby enhancing the water quality of the watershed.

To avoid damage to the filter strip consider using vegetation that is somewhat tolerant to herbicides used in the upslope crop rotation.

Consider using this practice to enhance the conservation of declining species of wildlife, including those that are threatened or endangered.

Consider using this practice to protect National Register listed or eligible (significant) archaeological and traditional cultural properties from potential damaging contaminants.

Filter strip size should be adjusted to a greater flow length to accommodate harvest and maintenance equipment.

PLANS AND SPECIFICATIONS

Based on this standard, plans and specifications shall be prepared for each specific field site where a filter strip will be installed. A plan includes information about the location, construction sequence, vegetation establishment, and management and maintenance requirements.

Specifications will include:

a) Length, width, and slope of the filter strip to accomplish the planned purpose (length refers to flow length across the filter strip).

b) Species selection and seeding or sprigging rates to accomplish the planned purpose

c) Planting dates, care, and handling of the seed to ensure that planted materials have an acceptable rate of survival

d) A statement that only viable, high quality, and regionally adapted seed will be used

e) Site preparation sufficient to establish and grow selected species

OPERATION AND MAINTENANCE

For the purposes of filtering contaminants, permanent filter strip vegetative plantings should be harvested as appropriate to encourage dense growth, maintain an upright growth habit, and remove nutrients and other contaminants that are contained in the plant tissue.

Control undesired weed species, especially state-listed noxious weeds.

Prescribed burning may be used to manage and maintain the filter strip when an approved burn plan has been developed.

Inspect the filter strip after storm events and repair any gullies that have formed, remove unevenly deposited sediment accumulation that will disrupt sheet flow, reseed disturbed areas, and take other measures to prevent concentrated flow through the filter strip

Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the filter strip.

To maintain or restore the filter strip's function, periodically regrade the filter strip area when sediment deposition at the filter strip-field interface jeopardizes its function, and then reestablish the filter strip vegetation, if needed. If wildlife habitat is a purpose, destruction of vegetation within the portion of the strip devoted to that purpose should be minimized by regrading only to the extent needed to remove sediment and fill concentrated flow areas.

Grazing shall not be permitted in the filter strip unless a controlled grazing system is being implemented. Grazing will be permitted under a controlled grazing system only when soil moisture conditions support livestock traffic without excessive compaction.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

CONTOUR BUFFER STRIPS

(Acre)

CODE 332

DEFINITION

Narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel, wider cropped strips.

PURPOSES

- To reduce sheet and rill erosion.
- To reduce transport of sediment and other water-borne contaminants downslope, on-site or off-site.
- To enhance wildlife habitat

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to cropland. It is most suitable on uniform slopes ranging from 4 to 8 percent with slope lengths less than the Critical Slope Length (Critical Slope Length = length of slope above which contouring loses its effectiveness). It is also most suitable in regions where rainfall intensities are low to moderate (10 year EI less than 140). EI = storm energy * intensity.

This practice is not suited to fields with extremely long slopes whose length exceeds the critical slope length for contouring by more than 1.5 times, unless the field slope length is shortened by the installation of other practices (e.g. terraces).

The practice is more difficult to establish on undulating to rolling topography because of the difficulty of maintaining parallel strip boundaries across the hill slope or staying within row grade limits.

The narrow strips of permanent vegetative cover are not a part of the normal crop rotation.

This standard does not apply to situations where the width of the buffer strips will be equal to or exceed the width of the adjoining crop strips.

CRITERIA

Criteria Applicable to Both Reducing Sheet and Rill Erosion and Reducing Transport of Sediment and Water-Borne Contaminants.

a. Row Grade, Strip Boundaries, and Baselines

The grade of the cropped strip shall be aligned as closely as possible to the contour to achieve the greatest erosion reduction possible. The maximum grade of rows within the crop strips shall not exceed one half of the up and down hill field slope or 2 percent, whichever is less.

For crops sensitive to ponded water for periods less than 48 hours, design a positive row grade of not less than 0.5 percent from the nose of a hill or ridge toward a stable outlet. Up to 3 percent row grade is allowed for a maximum of 150 feet as crop rows approach a stable outlet.

The grade along the up slope side of the vegetated buffer shall be the same as for the cropped strip directly above it.

Conservation practice standards are reviewed periodically, and updated as needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

When the grade of any crop strip reaches the maximum allowable design grade, a new baseline shall be established up or down slope from the last buffer strip and used for the layout of the next crop strip.

b. Arrangement of Strips

Cropped strips shall be alternated with buffer strips down the hill slope. Normally, a crop strip will occupy the area at the top of the hill.

When used in combination with terraces with underground outlets, diversions, or water and sediment control basins, the layout of buffer strips shall be coordinated with the grade and spacing of the terraces so that strip boundaries will parallel terraces wherever possible. The buffer strip shall occupy the terrace or diversion berm, a channel leading to a water and sediment control basin, or lie immediately up slope of the terrace or diversion channel.

c. Stable Outlets

Surface flow from contoured crop rows must go to a stable outlet. Stable outlets include grassed waterways, underground outlets for terraces or diversions, water and sediment control basins, field borders, headlands or end rows, or similarly stabilized areas.

Additional Criteria to Reduce Sheet and Rill Erosion

a. Width of Strips

The buffer strips shall be of equal width, except when a varying width buffer strip is needed to keep either a cropped strip adjacent to it of uniform width or to maintain the strip boundary grades within the criteria set above. Width of buffer strips at their narrowest point shall be no less than 15 feet for grasses or grass legume mixtures and no less than 30 feet when legumes are used alone.

Cropped strips shall be of uniform width between buffer strips and not exceed the lesser of:

(1) 50 percent of the slope length (L), used for the erosion calculation, or

(2) 50 percent of the critical slope length for contour buffer strips. (The critical slope length for contour buffer strips is calculated by multiplying 1.5 times the critical slope length for contour farming as determined by using approved erosion prediction technology).

Cropped strip width shall be designed to account for some multiple of full equipment width.

b. Vegetation

Vegetation grown on buffer strips designed to reduce sheet and rill erosion shall be established to permanent vegetation consisting of grasses, legumes, or grass-legume mixtures, adapted to the site, and tolerant of the anticipated depth of sediment deposition. No plants listed on the noxious weed list of the state will be established in a buffer strip cropping system.

The buffer strips shall have a Vegetative Cover-Management Condition of 1 (established meadow - very dense cover) or 2 (1st year meadow or grass legume hay just before cutting) that provides protective cover and induces sediment deposition during periods when erosion is expected to occur on the cropped strips. Cropped strips will normally be expected to have a Cover-Management Condition within the range from 3 (heavy dense cover or very rough) through 7 (Clean tilled, smooth or fallow). (Cover Management Conditions are described in Chapter 6, Predicting Soil Erosion by Water, A Guide to Conservation Planning with the Revised Universal soil Loss Equation "RUSLE")

The stem density for grass species shall be greater than 50, and for legumes, greater than 30 stems per square foot.

c. Level of Erosion control

The level of erosion control achieved by the buffer strip cropping practice shall meet or exceed the soil erosion level specified by the conservation plan objective. It shall be determined using the approved erosion prediction technology, accounting for the impact of other conservation practices in the system.

e. Headlands or End Rows

On fields where row crops are a part of the rotation, keep headlands or end rows in permanent sod if their row grade would be steeper than the designed grade of the crop strip.

<u>Additional Criteria to Reduce the Transport of Sediment and Other Water-Borne Contaminants Downslope</u>

a. Vegetation

Buffer strips designed to reduce the transport of sediment and other water-borne contaminants shall be established to permanent sod forming vegetation with stiff, upright stems only. No plants listed on the noxious weed list of the state will be established in a buffer strip cropping system.

b. Width of Strips

On cropland having slopes exceeding 3 percent, the buffer strip width shall be based on the minimum criteria given above to reduce sheet and rill erosion. On slopes 3 percent or flatter, the width of the buffer strip shall be 15 feet or wider.

The maximum width of cropped strips between buffer strips shall be one half of the field slope length not to exceed 150 feet. Cropped strip width shall be designed to account for some multiple of full equipment width.

c. Arrangement of Strips

Buffer strips and crop strips will be alternated down the hill slope. A buffer strip will be established at the bottom of the slope. This width of this buffer strip will be two times the width of the other buffer strips in the system.

d. Headlands or End Rows

Headlands or end rows shall be vegetated and have a minimum width of 15 feet between the end of the tilled strip and the field's edge.

<u>Additional Criteria to Enhance Wildlife Habitat</u>

To enhance wildlife habitat, native, warm season grass specie mixture, recommended for wildlife purposes, will be used where adapted.

Delay mowing the buffer strips to every other year or every third year depending upon geographical location.

Mow only after the desired species of ground nesting birds have hatched. Allow for regrowth before the growing season ends.

To enhance wildlife cover, the width of buffer strips will be increased to 30 feet or wider as determined based on the requirements for nesting and escape cover of the target wildlife species.

The maximum width between buffer strips should not exceed 300 feet.

CONSIDERATIONS

Protect areas of existing or potential concentrated flow erosion by any one or more suitable conservation practices, such as grassed waterways, water and sediment control basins, or diversion terraces.

When the slope length exceeds the critical slope length for the cover-management condition that best characterizes the field to be contour buffer stripped, establish structures, such as terraces, to reduce the slope length below critical if the soil loss objective is not reached. (Design Guidance: Critical slope lengths can be increased by retaining crop residue on the soil surface of the cultivated strips using crop residue management practices. Certain tillage practices can also be used on the cultivated strips to increase random roughness to cause deposition to occur in depressions between soil clods. However, if the cropped strips are kept very rough, in high ridges, or under heavy residue cover, the need for contour buffer strips as an erosion and sediment reduction practice will be reduced since less sediment will be delivered to them.)

On fields where row crops are a part of the rotation, consider establishing field borders on headlands or end rows, which are steeper than the designed grade of rows in the cropped strip. Where contour row curvature becomes too sharp to keep equipment aligned with rows during field operations, consider increasing the buffer strip width to avoid sharp ridge points. In drainageways, consider establishing grassed waterways at least to the point of sharp curvature. These strips should be wide enough to allow the equipment to be lifted and/or turned to meet the same rows across the turn strip.

Prior to design and layout, consider removing any obstructions or making changes in field boundaries or shape, where feasible, to improve the effectiveness of the practice and the ease of performing farming operations.

Prior to layout, inspect the field's position on the landscape to find key points for commencing layout or getting the width of one set of strips (one cultivated and one buffer) to pass by an obstruction or ridge saddle. Considering grade limits, whenever possible, run strip boundaries parallel with fence lines or other barriers. Account for uncropped access road widths when they must traverse the field by adjusting strip boundaries on either side accordingly.

Some non-noxious weedy growth may be allowed in the strips as they provide an insect source for young birds. Also, consider adding native forbs to the seeding mixture when they are available.

The standing residual cover provides early and late season nesting and escape cover for many species of wildlife displaced from other mowed areas.

PLANS AND SPECIFICATIONS

Specifications for installation, operation, and maintenance of Contour Buffer Strips shall be prepared for each field according to the Criteria, Considerations, and Operations and Maintenance described in this standard, and shall be recorded on specification sheets, job sheets, narrative statements in conservation plans, or other acceptable documentation.

OPERATION AND MAINTENANCE

Conduct all farming operations parallel to the strip boundaries except on headlands or end rows with gradients less than the criteria set forth in this standard.

Time mowing of buffer strips to maintain appropriate vegetative density and height for optimum trapping of sediment from the upslope cropped strip during the critical erosion period(s). If wildlife enhancement is desired, delay mowing until after the desired species of ground nesting birds have hatched.

Fertilize buffer strips as needed to maintain stand density.

Mow sod turn strips and waterways at least annually.

Spot seed or totally renovate buffer strip systems damaged by herbicide application after residual action of the herbicide is complete.

Redistribute sediment accumulations along the upslope edge of the buffer-crop strip interface upslope over the cultivated strip when needed to maintain uniform sheet flow along the buffer/cropped strip boundary. If sediment accumulates just below the upslope edge of the buffer strip to a depth of 6 inches or stem density falls below specified amounts in the buffer strip, relocate the buffer/cropped strip interface location. Cultivated strips and buffer strips shall be rotated so that a mature stand of protective cover is achieved in a newly established buffer strip immediately below or above the old buffer strip before removing the old buffer to plant an erosion-prone crop. Alternate repositioning of buffer strips to maintain their relative position on the hill slope.

Renovate vegetated headlands or end row area as needed to keep ground cover above 65 percent.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

CONTOUR FARMING

(Acre)

CODE 330

DEFINITION

Tillage, planting, and other farming operations performed on or near the contour of the field slope.

PURPOSES

- To reduce sheet and rill erosion.
- To reduce transport of sediment and other water-borne contaminants.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on sloping land where crops are grown.

Contour farming is most effective on slopes between 2 and 10 percent. This practice will be less effective in achieving the stated purpose(s) on slopes exceeding 10 percent and in areas with 10-year-frequency, single storm EI values greater than 140. The practice is not well suited to rolling topography having a high degree of slope irregularity because of the difficulty meeting row grade criteria. (EI = total storm energy times the maximum 30-minute intensity).

CRITERIA

General Criteria Applicable to All Purposes

Minimum Row Grade

Row grades for soils with slow to very slow infiltration rates (soil hydrologic groups C or D), or for crops sensitive to ponded water conditions for periods of less than 48 hours, shall be designed with positive row drainage of not less than 0.2 percent on slopes where ponding is a concern.

Maximum Row Grade

The row grade shall be aligned as closely as possible to the contour to achieve the greatest erosion reduction. The maximum grade of rows shall not exceed 2 percent or one half of the up and down hill slope percent used for erosion prediction, whichever is less. Up to 3 percent row grade may be permitted within 150 feet of the approach to a *grassed waterway, field border* or other stable outlet.

Headlands or end rows that are steeper than the maximum row grade criteria stated above shall have a cover-management condition no greater than 3 or established to permanent field borders. [Cover-Management Conditions are described in Chapter 6, *Predicting Soil Erosion by Water, A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). 1997.* USDA Agricultural Research Service, Agricultural Handbook No. 703].

When the row grade reaches the maximum allowable design grade, a new baseline shall be established up or down slope from the last contour line and used for layout of the next contour pattern. All tillage and planting operations will follow the contour line established.

Minimum Ridge Height

The ridge height shall be designed to reduce soil erosion compared to that of rows oriented up and down the slope. As a minimum, this practice shall be designed to achieve a 0.5-2 inch ridge height during the period of the rotation that is most vulnerable to soil erosion. Ridge height design will be determined using

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on site conditions and current erosion prediction technology approved for use.

The minimum ridge height criteria is not required for close-grown crops, such as small grains, when runoff is reduced compared to that of rows planted up and down the slope. As a minimum, plant height shall be at least 6 inches high and the spacing between plants within the row shall not be greater than 2 inches.

The minimum ridge height criteria is not required where the practice *residue management, no-till/strip-till* is used on the contour if at least 50 percent surface residue is present between the rows after planting.

Critical Slope Length

A contour farming layout shall not occur on a hill slope that is longer than the critical slope length, unless supported by other practices (e.g., *terraces, diversions*) that either reduce slope length below the critical length or reduce overland flow velocities. Increasing residue cover and roughness will change the vegetative cover-management conditions and decrease overland flow velocities. Increasing roughness alone is not sufficient to reduce the critical slope length.

The computation of critical slope length shall be determined using approved erosion prediction technology.

Stable Outlets

All runoff from contouring shall be delivered to stable outlets, such as *grassed waterways, field borders, water and sediment control basins, or underground outlets for terraces and diversions.*

CONSIDERATIONS

Prior to design and layout, obstruction removal and changes in field boundaries or shape should be considered, where feasible, to improve the effectiveness of the practice and the ease of performing farming operations.

If using *residue management, ridge-till* on the contour, avoid crossing over ridged rows at correction areas. Consider sod turn strips if correction areas are unavoidable.

Ridge height may vary throughout the year as a result of tillage, planting, some harvest operations, hilling, row cultivation, and weathering. Use of the variable ridge height may be needed in some areas.

The width of correction areas, and the distance between baselines, should be adjusted for equipment operation widths.

Grassed waterways, water and sediment control basins, underground outlets, or other suitable practices should be used to protect areas of existing or potential concentrated flow erosion.

There are several factors that impact the effectiveness of contour farming to reduce soil erosion. These factors include: 10-year storm EI_{10} value, ridge height, furrow grade, slope steepness, soil hydrologic group, cover and roughness, and the critical slope length. Cover and roughness, row grade, and ridge height can be influenced by management and provide more or less benefit depending on design.

Contour farming may need to be used in combination with other conservation practices to meet the goals of the conservation management system.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field according to the Criteria, Considerations, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

Perform all tillage and planting operations parallel to contour baselines or *terraces, diversions, or contour buffer strip* boundaries where these practices are used, provided the applicable row grade criteria are met.

Where *terraces, diversions, or contour buffer strips* are not present, maintain contour markers on grades that, when followed during establishment of each crop, will maintain crop rows at designed grades. Contour markers may be field boundaries, a crop row left untilled near or on an original contour baseline, or other readily identifiable, continuous, lasting marker. All tillage and planting operations shall be parallel to the established marker. If a marker is lost, re-establish a contour baseline within the applicable criteria set forth by this standard prior to seedbed preparation for the next crop.

Farming operations should begin on the contour baselines and proceed both up and down the slope in a parallel pattern until patterns meet. Where field operations begin to converge between two non-parallel contour baselines, establish a correction area that is either permanently in sod, established to an annual close-grown crop, or is in cover-management condition 3.

Where contour row curvature becomes too sharp to keep machinery aligned with rows during field operations, establish sod turn strips on sharp ridge points or other odd areas as needed.

Renovate *field borders* as needed to maintain at least 65 percent ground cover. Maintain adequate field border width to allow farm implements room to turn.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

CHANNEL VEGETATION

(acre)
CODE 322

DEFINITION

Establishing and maintaining adequate plants on channel banks, berms, spoil, and associated areas.

PURPOSE

To stabilize channel banks and adjacent areas and reduce erosion and sedimentation. To maintain or enhance the quality of the environment, including visual aspects and fish and wildlife habitat.

SCOPE

This standard applies to the vegetation of open channels, streams, or ditches. It applies to Floodwater Diversions (400), Floodways (404), Open Channels (582), Stream Channel Stabilization (584), Streambank Protection (580), and Surface Drainage, Main Or Lateral (607-B). It does not apply to Diversions (362), Grassed Waterways Or Outlets (412), or Surface Drainage, Field Ditches (607-A).

CONDITIONS WHERE PRACTICE APPLIES

On channel banks, berms, spoil, and associated areas; except grassed waterways, diversions and areas with protective linings, those covered with water for an extended period, or in areas where conditions will not support adequate vegetation.

PLANNING CONSIDERATIONS

Evaluate slopes and soil material, time of year for proper establishment of vegetation, necessity for irrigation, visual aspects, fish and wildlife, fire hazards and special needs when construction is done from one side. Other considerations include:

1. Protection of channel vegetation from sediment deposits resulting from wind and water erosion;

2. Provisions for safety and protection of human life and property in all aspects of designs, application, and maintenance;

3. Methods by which endangered and threatened plants and nationally recognized natural vegetated areas will be identified and protected;

4. Requirements for overseeding or planting woody or herbaceous vegetation on the unexcavated side when construction is done from one side;

5. Identification of desirable trees and other vegetation and means for their preservation; and

6. Special techniques for establishing and maintaining vegetation near inlets, outlets, or other appurtenances.

SPECIFICATIONS GUIDE

An adequate vegetative cover stabilizes the channel area and provides for temporary or permanent protection or both.

Slides slopes. Specify side slopes that permit establishing and maintaining desired vegetation and that have been effective in the past. In urban and recreation areas, flatter

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side slopes may be required to provide for public safety and enhancement of visual resources.

Species selection. Specify species that are suited to the soil, climate, and exposure. They must provide a lasting cover to protect the channel area and to maintain the channel design capacity. Use special purpose plantings outside the channel for wildlife, recreation, or visual resources.

Seedbed preparation. Specify seedbed preparation, fill rills and gullies, and remove stones and debris.

Fertilizer and soil amendments. Specify fertilizers and soil amendments, including analyses, rate, method of application, and requirements for top-dressing.

Planting. Specify dates, rates, and methods of seeding sprigging, sodding or planting.

Mulching. Specify types and rates of mulch materials and the methods of anchoring.

Irrigation. Specify irrigation if it is needed for establishing vegetation.

Controlled access. Control access to channels, as needed by fencing or by other means to protect slopes and vegetation from damage.

Maintenance. Provide for:

1. Periodic inspection and evaluation of channel vegetation to determine maintenance needs.

2. Management of vegetation growth, as applicable, by mowing controlled grazing, approved chemicals, or other means to maintain the desired cover.

3. Reseeding or replanting, along with the use of fertilizers and/or soil amendments and irrigation, as needed.

4. Repair of appurtenances and fences.

PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY

Quantity

1. Potential runoff from bare soil during construction.

2. Effects on the water budget components, especially on volumes and rates of runoff.

Quality

1. Effects of nutrients or pesticides in runoff during establishment of vegetation.

2. Effects of streambank erosion before vegetative establishment.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Acre)

CODE 590

DEFINITION

Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

PURPOSES

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To maintain or improve the physical, chemical and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

Plans for nutrient management shall comply with all applicable Federal, state, and local laws and regulations.

Plans for nutrient management shall be developed in accordance with policy requirements of the NRCS General Manual Title 450, Part 401.03 (Technical Guides, Policy and Responsibilities) and Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy); technical requirements of the NRCS Field Office Technical Guide (FOTG); procedures contained in the National Planning Procedures Handbook (NPPH), and the NRCS National Agronomy Manual (NAM) Section 503.

Persons who review or approve plans for nutrient management shall be certified through any certification program acceptable to NRCS within the state.

Plans for nutrient management that are elements of a more comprehensive conservation plan shall recognize other requirements of the conservation plan and be compatible with its other requirements.

A nutrient budget for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to animal manure and organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water.

Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soil, cropping systems, and soil and manure/organic by-products tests. For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Plans for nutrient management shall specify the form, source, amount, timing and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and/or phosphorus movement to surface and/or ground waters.

Erosion, runoff, and water management controls shall be installed, as needed, on fields that receive nutrients.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources conservation Service.

Soil Sampling and Laboratory Analysis (Testing)

Nutrient planning shall be based on current soil test results developed in accordance with Land Grant University guidance or industry practice if recognized by the Land Grant University. Current soil tests are those that are no older than five years.

Soil samples shall be collected and prepared according to the Land Grant University guidance or standard industry practice. Soil test analyses shall be performed by laboratories that are accepted in one or more of the following programs:

- State Certified Programs,
- The North American Proficiency Testing Program (Soil Science Society of America), or
- Laboratories whose tests are accepted by the Land Grant University in the state in which the tests will be used.

Soil testing shall include analysis for any nutrients for which specific information is needed to develop the nutrient plan. Request analyses pertinent to monitoring or amending the annual nutrient budget, e.g. pH, electrical conductivity (EC), soil organic matter, nitrogen, phosphorus, and potassium.

Plant Tissue Testing

Tissue sampling and testing, where used, shall be done in accordance with Land Grant University standards or recommendations.

Nutrient Application Rates

Soil amendments shall be applied, as needed, to adjust soil pH to the specific range of the crop for optimum availability and utilization of nutrients.

Recommended nutrient application rates shall be based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities. If the Land Grant University does not provide specific recommendations, application shall be based on realistic yield goals and associated plant nutrient uptake rates.

The planned rates of nutrient application, as documented in the nutrient budget, shall be determined based on the following guidance:

- **Nitrogen Application** - Planned nitrogen application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- **Phosphorus Application** - Planned phosphorus application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- **Potassium Application** - Excess potassium shall not be applied in situations in which it causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, state standards shall be used to set forage quality guidelines.
- **Other Plant Nutrients** - The planned rates of application of other nutrients shall be consistent with Land Grant University guidance or industry practice if recognized by the Land Grant University in the state.
- **Starter Fertilizers** - Starter fertilizers containing nitrogen, phosphorus and potassium may be applied in accordance with Land Grant University recommendations, or industry practice if recognized by the Land Grant University within the state. When starter fertilizers are used, they shall be included in the nutrient budget.

Nutrient Application Timing

Timing and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, and field accessibility.

Nutrient Application Methods

Nutrients shall not be applied to frozen, snow-covered, or saturated soil if the potential risk for runoff exists.

Nutrient applications associated with irrigation systems shall be applied in accordance with the requirements of Irrigation Water Management (Code 449).

Additional Criteria Applicable to Manure or Organic By-Products Applied as a Plant Nutrient Source

Nutrient values of manure and organic by-products (excluding sewage sludge) shall be determined prior to land application based on laboratory analysis, acceptable "book values" recognized by the NRCS and/or the Land Grant University, or historic records for the operation, if they accurately estimate the nutrient content of the material. Book values recognized by NRCS may be found in the Agricultural Waste Management Field Handbook, Chapter 4 - Agricultural Waste Characteristics.

Nutrient Application Rates

The application rate (in/hr) for material applied through irrigation shall not exceed the soil intake/infiltration rate. The total application shall not exceed the field capacity of the soil.

The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

- **Nitrogen Application** - When the plan is being implemented on a phosphorus standard, manure or other organic by-products shall be applied at rates consistent with the phosphorus standard. In such situations, an additional nitrogen application, from non-organic sources, may be required to supply the recommended amounts of nitrogen.

  Manure or other organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass.

- **Phosphorus Application** - When manure or other organic by-products are used, the planned rates of phosphorus application shall be consistent with any one of the following options:
  - **Phosphorus Index (PI) Rating.** Nitrogen based manure application on Low or Medium Risk Sites, phosphorus based or no manure application on High and Very High Risk Sites.**
  - **Soil Phosphorus Threshold Values.** Nitrogen based manure application on sites on which the soil test phosphorus levels are below the threshold values. Phosphorus based or no manure application on sites on which soil phosphorus levels equal or exceed threshold values.**
  - **Soil Test.** Nitrogen based manure application on sites on which there is a soil test recommendation to apply phosphorus. Phosphorus based or no manure application on sites on which there is no soil test recommendation to apply phosphorus.**

  ** Acceptable phosphorus based manure application rates shall be determined as a function of soil test recommendation or estimated phosphorus removal in harvested plant biomass. Guidance for developing these acceptable rates is found in the NRCS General Manual, Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy), and the National Agronomy Manual, Section 503.

A single application of phosphorus applied as manure may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence. When such applications are made, the application rate shall:

- not exceed the recommended nitrogen application rate during the year of application, or
- not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when

there is no recommended nitrogen application.

- not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices, best management practices, or management activities are used to reduce the vulnerability.

Field Risk Assessment

When animal manures or other organic by-products are applied, a field-specific assessment of the potential for phosphorus transport from the field shall be completed. This assessment may be done using the Phosphorus Index or other recognized assessment tool. In such cases, plans shall include:

- a record of the assessment rating for each field or sub-field, and
- information about conservation practices and management activities that can reduce the potential for phosphorus movement from the site.

When such assessments are done, the results of the assessment and recommendations shall be discussed with the producer during the development of the plan.

Heavy Metals Monitoring

When sewage sludge is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations.

Additional Criteria to Minimize Agricultural Non-point Source Pollution of Surface and Ground Water Resources

In areas with an identified or designated nutrient-related water quality impairment, an assessment shall be completed of the potential for nitrogen and/or phosphorus transport from the field. The Leaching Index (LI) and/or Phosphorus Index (PI), or other recognized assessment tools, may be used to make these assessments. The results of these assessments and recommendations shall be discussed with the producer and included in the plan.

Plans developed to minimize agricultural nonpoint source pollution of surface or ground water resources shall include practices and/or management activities that can reduce the risk of nitrogen or phosphorus movement from the field.

Additional Criteria to Improve the Physical, Chemical, and Biological Condition of the Soil.

Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition. Use of nutrient sources with high salt content will be minimized unless provisions are used to leach salts below the crop root zone.

Nutrients shall not be applied to flooded or saturated soils when the potential for soil compaction and creation of ruts is high.

CONSIDERATIONS

Consider induced deficiencies of nutrients due to excessive levels of other nutrients.

Consider additional practices such as Conservation Cover (327), Grassed Waterway (412), Contour Buffer Strips (332), Filter Strips (393), Irrigation Water Management (449), Riparian Forest Buffer (391A), Conservation Crop Rotation (328), Cover and Green Manure (340), and Residue Management (329A, 329B, or 329C, and 344) to improve soil nutrient and water storage, infiltration, aeration, tilth, diversity of soil organisms and to protect or improve water quality.

Consider cover crops whenever possible to utilize and recycle residual nitrogen.

Consider application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere. Suggestions include:

- split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- avoiding winter nutrient application for spring seeded crops,

- band applications of phosphorus near the seed row,
- applying nutrient materials uniformly to application areas or as prescribed by precision agricultural techniques, and/or
- immediate incorporation of land applied manures or organic by-products,
- delaying field application of animal manures or other organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.

Consider minimum application setback distances from environmentally sensitive areas, such as sinkholes, wells, gullies, ditches, surface inlets or rapidly permeable soil areas.

Consider the potential problems from odors associated with the land application of animal manures, especially when applied near or upwind of residences.

Consider nitrogen volatilization losses associated with the land application of animal manures. Volatilization losses can become significant, if manure is not immediately incorporated into the soil after application.

Consider the potential to affect National Register listed or eligible cultural resources.

Consider using soil test information no older than one year when developing new plans, particularly if animal manures are to be a nutrient source.

Consider annual reviews to determine if changes in the nutrient budget are desirable (or needed) for the next planned crop.

On sites on which there are special environmental concerns, consider other sampling techniques. (For example: Soil profile sampling for nitrogen, Pre-Sidedress Nitrogen Test (PSNT), Pre-Plant Soil Nitrate Test (PPSN) or soil surface sampling for phosphorus accumulation or pH changes.)

Consider ways to modify the chemistry of animal manure, including modification of the animal's diet to reduce the manure nutrient content, to enhance the producer's ability to manage manure effectively.

PLANS AND SPECIFICATIONS

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan:

- aerial photograph or map and a soil map of the site,
- current and/or planned plant production sequence or crop rotation,
- results of soil, plant, water, manure or organic by-product sample analyses,
- realistic yield goals for the crops in the rotation,
- quantification of all nutrient sources,
- recommended nutrient rates, timing, form, and method of application and incorporation,
- location of designated sensitive areas or resources and the associated, nutrient management restriction,
- guidance for implementation, operation, maintenance, recordkeeping, and
- complete nutrient budget for nitrogen, phosphorus, and potassium for the rotation or crop sequence.

If increases in soil phosphorus levels are expected, plans shall document:

- the soil phosphorus levels at which it may be desirable to convert to phosphorus based implementation,
- the relationship between soil phosphorus levels and potential for phosphorus transport from the field, and
- the potential for soil phosphorus drawdown from the production and harvesting of crops.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

In addition to the requirements described above, plans for nutrient management shall also include:

- discussion about the relationship between nitrogen and phosphorus transport and water quality impairment. The discussion about nitrogen should include information about nitrogen leaching into shallow ground water and potential health impacts. The discussion about phosphorus should include information about phosphorus accumulation in the soil, the increased potential for phosphorus transport in soluble form, and the types of water quality impairment that could result from phosphorus movement into surface water bodies.
- discussion about how the plan is intended to prevent the nutrients (nitrogen and phosphorus) supplied for production purposes from contributing to water quality impairment.
- a statement that the plan was developed based on the requirements of the current standard and any applicable Federal, state, or local regulations or policies; and that changes in any of these requirements may necessitate a revision of the plan.

OPERATION AND MAINTENANCE

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

- periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle.
- protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- calibration of application equipment to ensure uniform distribution of material at planned rates.
- documentation of the actual rate at which nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences.
- Maintaining records to document plan implementation. As applicable, records include:
    - soil test results and recommendations for nutrient application,
    - quantities, analyses and sources of nutrients applied,
    - dates and method of nutrient applications,
    - crops planted, planting and harvest dates, yields, and crop residues removed,
    - results of water, plant, and organic by-product analyses, and
    - dates of review and person performing the review, and recommendations that resulted from the review.

Records should be maintained for five years; or for a period longer than five years if required by other Federal, state, or local ordinances, or program or contract requirements.

Workers should be protected from and avoid unnecessary contact with chemical fertilizers and organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with organic wastes stored in unventilated enclosures.

The disposal of material generated by the cleaning nutrient application equipment should be accomplished properly. Excess material should be collected and stored or field applied in an appropriate manner. Excess material should not be applied on areas of high potential risk for runoff and leaching.

The disposal or recycling of nutrient containers should be done according to state and local guidelines or regulations.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SEDIMENT BASIN

(No.)
CODE 350

DEFINITION

A basin constructed to collect and store debris or sediment.

SCOPE

This standard applies to the installation of all basins where the primary purpose is to trap and store waterborne sediment and debris.

PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversion, waterways, and streams; to prevent undesirable deposition on bottom lands and developed areas; to trap sediment originating from construction sites; and to reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes, and other detritus.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where physical conditions or land ownership preclude treatment of a sediment source by the installation of erosion-control measures to keep soil and other material in place or where a sediment basin offers the most practical solution to the problem.

PLANNING CONSIDERATIONS

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.

2. Effects on downstream flows and aquifers that would affect other water uses and users.

3. Effects on volume of discharge flow on the environmental, social, and economic conditions.

4. Effects on the water table downstream and the results of changes of vegetative growth.

Water Quality

1. Effects on erosion, movement of sediment, pathogens, and soluble and sediment-attached substances that could be carried by runoff.

2. Effects on the visual quality of onsite and downstream water resources.

3. Effects of construction and early establishment of protective vegetation on the surface and ground water.

4. Effects on wetlands and water-related wildlife habitats.

DESIGN CRITERIA

The capacity of the sediment basin shall equal the volume of sediment expected to be trapped at the site during the planned useful life of the basin or the improvements it is designed to protect. If it is determined that periodic removal of sediment will be practicable, the capacity may be proportionately reduced.

The design of dams, spillways, and drainage facilities shall be according to SCS standards

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resource Conservation Service.

for ponds (378) and grade stabilization structures (410) or according to the requirements in TR-60, as appropriate for the class and kind of structure being considered.

Temporary basins having drainage areas of 5 acres or less and a total embankment height of 5 ft or less may be designed with less conservative criteria if conditions warrant. The embankment shall have a minimum top width of 4 ft and side sloped of 2:1 or flatter. An outlet shall be provided of earth, pipe, stone, or other devices adequate to keep the sediment in the trap and to handle the 10-year-frequency discharge without failure or significant erosion.

Provisions shall be made for draining sediment pools if necessary for safety and vector control. Fencing and other safety measures shall be installed as necessary to protect the public from floodwater and soft sediment. Due consideration shall be given to good visual resource management.

PLANS AND SPECIFICATIONS

Plans and specifications for installing sediment basins shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

STREAM CHANNEL STABILIZATION

(ft)
CODE 584

DEFINITION

Stabilizing the channel of a stream with suitable structures.

SCOPE

This standard applies to the structural work done to control aggradation or degradation in a stream channel. It does not include work done to prevent bank cutting or meander.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to stream channels undergoing damaging aggradation or degradation that cannot be feasibly controlled by clearing or snagging, by the establishment of vegetative protection, or by the installation of upstream water control facilities.

PLANNING CONSIDERATIONS

Water Quantity

1. Stage-discharge and flow velocity relative to the water budget components, geologic materials comprising the stream channel, and objectives of the channel modification.

2. Effects on water tables, soil moisture storage, and rooting depths and transpiration of vegetation.

Water Quality

1. Temporary and long-term effects on erosion and sedimentation.

2. Changes in stream water temperature that may result from the clearing of vegetation or alteration of water sources to the channel.

3. Effects on the visual quality of the water resource.

DESIGN CRITERIA

It is recognized that channels may aggrade or degrade during a given storm or over short periods. A channel is considered stable if over long periods the channel bottom remains essentially at the same elevation.

In the design of a channel for stability, consideration shall be given to the following points:

1. The character of the materials comprising the channel bottom.
2. The quantity and character of the sediments entering the reach of channel under consideration. This shall be analyzed on the basis of both present conditions and projected changes caused by changes in land use or land treatment and upstream improvements or structural measures.
3. Streamflow peaks, velocities, and volumes at various flow frequencies.
4. The effects of changes in velocity of the stream produced by the structural measures.

Structures installed to stabilize stream channels shall be designed and installed to meet SCS standards for the particular structure and type of construction.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

PLANS AND SPECIFICATIONS

Plans and specifications for stream channel stabilization shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

STREAMBANK AND SHORELINE PROTECTION

(Ft)

CODE 580

DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

PURPOSE

- To prevent the loss of land or damage to land uses, or other facilities adjacent to the banks, including the protection of known historical, archeological, and traditional cultural properties.
- To maintain the flow or storage capacity of the water body or to reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It applies to controlling erosion where the problem can be solved with relatively simple structural measures, vegetation, or upland erosion control practices. It does not apply to erosion problems on main oceanfronts and similar areas of complexity not normally within the scope of NRCS authority or expertise.

CRITERIA

General Criteria Applicable to All Purposes

Measures must be installed according to a site-specific plan and in accordance with all applicable local, state, and federal laws and regulations.

Protective measures to be applied shall be compatible with improvements planned or being carried out by others.

Protective measures shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics both above and below the water line.

End sections shall be adequately bonded to existing measures, terminate in stable areas, or be otherwise stabilized.

Protective measures shall be installed on stable slopes. Bank or shoreline materials and type of measure installed shall determine maximum slopes.

Designs will provide for protection from upslope runoff.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be used on structural measures where there is the potential for migration of material from behind the measure.

Measures applied shall not adversely affect threatened and endangered species nor species of special concern as defined by the appropriate state and federal agencies.

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Measures shall be designed for anticipated ice action and fluctuating water levels.

All disturbed areas around protective measures shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction.

Vegetation shall be selected that is best suited for the soil/moisture regime.

Additional Criteria for Streambanks

The channel grade shall be stable based on a field assessment before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour.

A protective toe shall be provided based on an evaluation of stream bed and bank stability.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion or structural failure. Habitat forming elements that provide cover, food, and pools, and water turbulence shall be retained or replaced to the extent possible.

Changes in channel alignment shall not be made unless the changes are based on an evaluation that includes an assessment of both upstream and downstream fluvial geomorphology. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Measures shall be functional for the design flow and sustainable for higher flow conditions based on acceptable risk.

Measures shall be designed to avoid an increase in natural erosion downstream.

Measures planned shall not limit stream flow access to the floodplain.

Stream segments to be protected shall be classified according to a system deemed appropriate by the state. Segments that are incised or contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

When water surface elevations are a concern, the effects of protective measures shall not increase flow levels above those that existed prior to installation.

Additional Criteria for Shorelines

All revetments, bulkheads, or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas

Structural shoreline protective measures shall be keyed to a depth to prevent scour during low water.

For the design of structural measures, the site characteristics below the waterline shall be evaluated for a minimum of 50 ft (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

Additional Criteria for Stream Corridor Improvement

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excess long-term channel migration in re-established stream corridors.

Measures shall be designed to achieve any habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives are based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Measures shall be designed to meet any aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives are based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Measures shall be designed to achieve any recreation objectives as determined by a site-specific assessment or management plan. Recreation objectives are based on type of human use and safety requirements.

CONSIDERATIONS

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment an interdisciplinary team should be utilized.

When designing protective measures, consider the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing debris removed from the channel or streambank into the treatment design.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within state and local regulations.

Measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife, including lowering or moderating water temperature, and improving water quality.

Consideration should be given to protecting side channel inlets and outlets from erosion.

Toe rock should be large enough to provide a stable base and graded to provide aquatic habitat.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed measures, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank.

Protective measures should be self-sustaining or require minimum maintenance.

PLANS AND SPECIFICATIONS

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites and based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WETLAND ENHANCEMENT

(acre)

CODE 659

DEFINITION

The modification or rehabilitation of an existing or degraded wetland, where specific functions and/or values are modified for the purpose of meeting specific project objectives. Some functions may remain unchanged while others may be degraded.

PURPOSE

To modify the hydrologic condition, hydrophytic plant communities, and/or other biological habitat components of a wetland for the purpose of favoring specific wetland functions or values. For example; managing site hydrology for waterfowl or amphibian use, or managing plant community composition for native wetland hay production.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on any degraded or existing wetland where the objective is to specifically enhance a selected wetland function(s)and/or value(s).

Enhancement should not significantly change the primary wetland functions provided at the site.

Upon completion of the enhancement the site will meet the current NRCS soils, hydrology, and vegetation criteria of a Wetland.

This practice does not apply to: a constructed wetland (656) intended to treat point and non-point sources of water pollution; wetland restoration (657) intended to rehabilitate a degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to original conditions; or wetland creation (658) for creating a wetland on a site location which historically was not a wetland or on a site which was formerly a wetland but will be replaced with a wetland type not naturally occurring on the site.

CRITERIA

General Criteria

The landowner shall obtain necessary local, state, and federal permits that apply before wetland enhancement.

Water rights are assured prior to enhancement if required.

The design will not back water on neighboring land without an easement.

Document the soil, hydrology, and vegetative characteristics of the site and its contributing watershed before alteration .

The potential for occurrence of threatened or endangered species shall be evaluated for each site proposed for enhancement. Sites containing threatened or endangered species will not be enhanced under this standard unless it can be demonstrated that the impact will benefit the species at risk.

If the presence of hazardous waste materials in the sediment or fill is suspected, soil samples will be collected and analyzed for the presence

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of hazardous waste as defined by local, state, or federal authorities. Sites containing hazardous waste will not be enhanced under this standard.

Criteria for Hydrology Enhancement

The hydrology of the site (defined as the rate and timing of inflow and outflow, source, duration, frequency, and depth of flooding, ponding or saturation) is modified to meet the project objectives. An adequate source of water must be available to meet designs for increased hydrology.

The standards and specifications for Dike (356) and Structure for Water Control (587) will be used as appropriate. Refer to the Engineering Field Handbook, Chapters 13, "Wetland Restoration, Enhancement, and Creation," and 6, "Structures," for additional design information. Existing drainage systems will be utilized, removed, or modified as needed to achieve the intended purpose.

Criteria for Vegetation Enhancement

Where possible, native plant materials shall be used; however, introduced or cultivated plant species can be used to meet specific project objectives. Introduced species may become invasive or detrimental and caution must be exercised.

When using native species, preference shall be given to native wetland plants with localized genetic material. Plant materials collected or grown from material collected within a 200 mile radius from the site is considered local.

In soils where seed banks realistically exist, or where natural colonization of targeted species will dominate within 5 years, then natural regeneration can be allowed. Specific guidelines that consider soil, seed source, and species will be developed by the states.

Adequate substrate material and site preparation necessary for proper establishment of the selected plant species shall be included in the design.

Criteria for Wetland Functions

A functional assessment (Hydrogeomorphic approach or similar method) shall be performed on the site prior to enhancement.

Project goals and objectives shall minimize adverse impacts to wetland functions not specifically targeted for enhancement.

Where possible, wetland functions not targeted for enhancement should also be maximized.

CONSIDERATIONS

Consider existing wetland functions and/or values that may be adversely impacted.

Consider effect of volumes and rates of runoff, infiltration, evaporation, and transpiration on the water budget.

Consider the potential for a change in rates of plant growth and transpiration because of changes in the volume of available soil water.

Consider effects on downstream flows or aquifers that would affect other water uses or users.

Consider effects on wetlands or water-related resources wildlife habitats that would be associated with the practice.

Consider linking wetlands by corridors wherever appropriate to enhance the wetland's use and colonization by the flora and fauna.

Consider establishing vegetative buffers on surrounding uplands to reduce sediment and soluble and sediment-attached substance carried by runoff and/or wind.

The nutrient and pesticide tolerance of the species planned should be considered where known nutrient and pesticide contamination exists.

Consider effects on temperature of water resources to prevent undesired effects on aquatic and wildlife communities.

PLANS AND SPECIFICATIONS

Specifications for this practice shall be prepared for each site. Specifications shall be recorded using approved specifications sheets, job sheets, narrative statements in the conservation plan, or other documentation. Requirements for the operation and maintenance of the practice shall be incorporated into site specifications.

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

Any use of fertilizers, mechanical treatments, prescribed burning, pesticides and other chemicals to assure the wetland enhancement function shall not compromise the intended purpose;

Biological control of undesirable plant species and pests (e.g., using predator or parasitic species) shall be implemented where available and feasible;

Timing and level setting of water control structures is required for the establishment of desired hydrologic conditions, for management of vegetation and for optimum wildlife use.

Inspection schedule for embankments and structures for damage assessment;

Depth of sediment accumulation to be allowed before removal is required;

Management needed to maintain vegetation, including control of unwanted vegetation;

Haying and livestock grazing will be managed to protect and enhance established and emerging vegetation.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

RECREATION TRAIL AND WALKWAY

(ft)
CODE 568

DEFINITION

A pathway prepared especially for pedestrian, equestrian, and cycle travel.

SCOPE

This standard applies to walkways and trails constructed in recreation and scenic areas.

PURPOSE

To provide users of recreation areas with travel routed for activities such as walking, sightseeing, horseback riding, and bicycling; to prevent erosion; and to preserve and protect soil, plant, animal, and visual resources.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to lands where prepared paths, trails, and walkways are needed for effective and safe use of the recreation resources.

PLANNING CONSIDERATIONS

Water Quantity

1. Impacts of impervious walkways and trails on increased surface runoff.

2. Changes in deep percolation with increased surface runoff. Consider evaporation losses before infiltration, evapotranspiration changes with decreased infiltration, and average changes in root zone storage.

Water Quality

1. Change in ground water quality caused by decreased dissolved chemical infiltration.

2. Potential changes in erosion and sediment yield caused by increase runoff and temporary increases in erosion during construction.

3. Effects of dissolved chemicals in runoff resulting from recreation activities.

DESIGN CRITERIA

Visual resources. Special attention shall be given to saving and maintaining key trees and other vegetation that have scenic value, provide shade, reduce erosion and runoff, provide den and food for wildlife, or add to the visual quality of the area.

Grade. Sustained grades shall be dictated by good judgment for the purpose intended, considering the topography, and shall not exceed 10 percent.

Width. Generally, the minimum treat width shall be 4 ft. The width in cuts for pedestrian trails on sidehill sections may be reduced to 3 ft if greater width would increase the cost materially or adversely affect the visual resources.

Side slopes. Cut and fill slopes shall be stable for the soil or soil material.

Drainage. Adequate drainage shall be provided. A raised or elevated trail or walkway

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may be required for wet sites that cannot be drained.

Erosion control. Plans shall include provisions for control of erosion. Distributed areas shall be established to vegetation as soon as practicable after construction. If soil or climatic conditions precludes the use of vegetation, and protection is needed, nonvegetative means, such as mulches or gravel, may be used. Seedbed preparation, seeding, fertilizing, and mulching shall comply with recommendations in technical guides.

Bridges. Bridges shall be designed for the maximum expected loading with and adequate factor of safety.

Surfacing. If surfacing is required for a firm trail, the surfacing material may be pit or creek-run gravel, concrete, asphalt, or other material that can withstand the traffic and the elements at the site.

Safety. Due consideration shall be given to safety. Protection from slides and falling rocks shall be provided, if needed. Adequate directional and warning signs, handrails, bridges, and culvert shall be placed as dictated by the site and intended use.

Maintenance. Provisions shall be made for maintaining all wearing surfaces, signs, and drainage structures.

General. Equestrian and pedestrian trails may vary from specific grades, widths, and clearing requirements if so dictated by location and topography.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing recreation trails and walkways shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

ANIMAL TRAILS AND WALKWAYS

(Ft.)
CODE 575

DEFINITION

A travel facility for livestock and/or wildlife to provide movement through difficult or ecologically sensitive terrain.

PURPOSES

This practice may be applied as part of a conservation management system to accomplish one or more of the following purposes:

* Provide or improve access to forage, water and/or shelter.
* Improve grazing efficiency and distribution.
* Divert travel away from ecologically sensitive and/or erosive sites.

CONDITIONS WHERE THIS PRACTICE APPLIES

On grazing lands where animal movement is impeded or restricted such as, steep rough terrain, across rock outcrops, through dense timber or brush, over lava beds, on marsh rangelands, and grazing lands susceptible to overflow by water.

CRITERIA

General Criteria Applicable For All The Purposes Stated Above.

Trails or walkways shall be constructed wide enough to accommodate movement of livestock and access by operator.

Trails or walkways shall be constructed in such a manner that accelerated erosion will not occur. Where necessary diversions with a safe outlet will be provided.

Trails or walkways seeded or planted to vegetative cover will be protected from grazing until planting material is fully established and capable of withstanding grazing and/or trampling.

Criteria Applicable For Walkways.

Walkways will be constructed to meet minimum height requirements above normal high water.

During the construction process of walkways, borrow pits will be staggered so that access to grazing areas and back to walkway will be available from either side.

When necessary structures will be installed to prevent interference with natural water movement or to control salt water intrusion.

CONSIDERATIONS

Other practices that facilitate grazing distribution and proper intensity such as prescribed grazing should be implemented along with this practice.

PLANS AND SPECIFICATIONS

Each trail or walkway shall have a site specific design based on the criteria in this standard and as supplemented by additional criteria developed by each individual State using this practice.

OPERATION AND MAINTENANCE

Operation will consist of periodic grading or shaping on trails and walkways to maintain designed dimensions. Maintenance will consist of repair that may be needed following major storm events such as high runoff events, high tides or other occurrences that cause damage

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and interfere in the normal operation of this practice.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATERING FACILITY

(No.)

CODE 614

DEFINITION

A device (tank, trough, or other watertight container) for providing animal access to water.

PURPOSE

To provide watering facilities for livestock and/or wildlife at selected locations in order to:

- protect and enhance vegetative cover through proper distribution of grazing;
- provide erosion control through better grassland management; or
- protect streams, ponds and water supplies from contamination by providing alternative access to water.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where there is a need for new or improved watering facilities.

CRITERIA

General Criteria Applicable To All Purposes

A trough or tank shall have adequate capacity to meet the water requirements of the livestock and/or wildlife. This will include the storage volume necessary to carry over between periods of replenishment. Animal water requirements can be obtained from the NRCS Engineering Field Handbook, Table 11-1.

Where water supplies are dependable and livestock are checked daily, troughs with little water storage capacity may be used. Troughs or tanks must provide the daily water requirement of the livestock and provide access to the entire herd within a short period of time.

The site shall be well drained; if not, drainage measures shall be provided. Areas adjacent to the trough or tank that will be trampled by livestock shall be graveled, paved, or otherwise treated to provide firm footing and reduce erosion. Design of the protective surface around the trough shall be in accordance with NRCS Conservation Practice Standard 561, Heavy Use Area Protection.

Automatic water level control and/or overflow facilities shall be provided as appropriate. Valves or pipes shall be protected by shields or covers to prevent damage by livestock. Overflow shall be piped to a stable or suitable point of release. The trough and outlet pipes shall be protected from freezing and ice damage. Freeze-proof troughs or electric heaters may be used.

When a roof is placed over the trough to provide shade, the roof shall be designed for appropriate snow and wind loads and shall be durable to withstand anticipated livestock and wildlife activities.

All materials shall have a life expectancy that meets or exceeds the planned useful life of the installation. Common construction materials are reinforced concrete, steel, fiberglass, plastic and wood. All designs shall meet the industry standards for the material being used. Generally applicable design requirements and procedures can be found in the documents referenced at the end of this standard.

Concrete structures shall be constructed from a concrete mix producing a minimum compressive strength of 3,000 psi at 28 days. Galvanized steel tanks shall have a minimum

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thickness of 20 gauge. Plastic and fiberglass structures shall be made of ultraviolet resistant materials or shall have a durable coating to protect the structure from deterioration due to sunlight.

CONSIDERATIONS

This practice may adversely affect cultural resources and must comply with GM 420, Part 401.

Topography should be evaluated to minimize trail erosion and flooding erosion from tank overflow.

Watering facilities should be accessible to small animals. Escape ramps for birds and small animals should be installed.

Adequate protection for livestock during the winter should be considered.

PLANS AND SPECIFICATIONS

Plans and specifications for installing troughs and tanks shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. If the trough and/or tank is a component of a system that includes additional conservation practices, the information necessary to construct these additional practices will also be conveyed on the plans.

Development of plans will be guided by Engineering Field Handbook, Chapter 5, and shall be in accordance with National Engineering Manual, Parts 541 and 542.

OPERATION AND MAINTENANCE

An O&M plan specific to the type of installed trough or tank shall be provided to the landowner. The plan shall include, but not be limited to, the following provisions:

- check for debris, algae, sludge or other materials in the trough which may restrict the inflow or outflow system;
- check for leaks and repair immediately if any leaks are found;
- check the automatic water level device to insure proper operation;
- check to ensure that adjacent areas are well protected against erosion;
- check to ensure the outlet pipe is freely operating and not causing erosion problems; and
- prepare guidance for winter weather, such as adding material in the storage area to allow for ice expansion without damage.

Algae and iron sludge accumulation should be addressed in areas with water quality that is known to cause problems. Chemicals such as copper sulfate and chlorine can be recommended as needed, as long as local rules and regulations are followed.

REFERENCES

Engineering Field Handbook

National Engineering Manual

Manual of Steel Construction, American Institute of Steel Construction

Timber, National Design Specification for Wood, American Forest and Paper Association

Concrete, ACI 318, American Concrete Institute

Masonry, Building Code Requirement for Masonry Structures, ACI 530, American Concrete Institute

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON

(No.)

CODE 359

DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources.
- to lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

CRITERIA

General Criteria for All Lagoons

Laws and Regulations. All Federal, state, and local laws, rules, and regulations governing the construction and use of waste treatment lagoons must be followed.

Location. To minimize the potential for contamination of streams, lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

Soils and foundation. The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless special design features are incorporated that address buoyant forces, lagoon seepage rates, and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains to meet this requirement.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resource Conservation Service.

Flexible membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in NRCS Practice Standard 521, Pond Sealing or Lining, Flexible Membrane Lining

Required volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, and other wastes accumulated during the treatment period;
- Depth of normal precipitation less evaporation on the surface area (at the required volume level) of the lagoon during the treatment period;
- Depth of the 25-year, 24-hour storm precipitation on the surface area (at the required volume level) of the lagoon.

Treatment period. The treatment period is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste considering the climate, crops, soil, and equipment requirements; or as required by local, state, and Federal regulations.

Waste loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. If local information is not available, Chapter 4 of the AWMFH may be used for estimating waste loading.

Embankments. The minimum elevation of the top of the settled embankment shall be 1 foot above the lagoon's required volume. This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent. The minimum top widths are shown in Table 1. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

Table 1 – Minimum Top Widths

Total embankment Height, ft.	Top Width, ft.
15 or less	8
15 – 20	10
20 – 25	12
25 – 30	14
30 – 35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration, while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

Outlet. Outlets from the required volume shall be designed to resist corrosion and plugging. No outlet shall automatically discharge from the required volume of the lagoon.

Facility for drawdown. Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc. shall permit drawdown without causing erosion or damage to liners.

Sludge removal. Provision shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon.

Erosion Protection. Embankments and disturbed areas surrounding the lagoon shall be treated to control erosion. This includes the inside slopes of the lagoon as needed to protect the integrity of the liner.

Safety. Design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

Additional Criteria for Anaerobic Lagoons

Loading rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 or according to state regulatory requirements, whichever is more stringent.

Operating levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event precipitation on the surface of the lagoon. The maximum drawdown level shall be the lagoon level that provides volume for the required minimum treatment volume plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. If subsurface conditions prevent practicable construction to accommodate the minimum depth at maximum drawdown, a lesser depth may be used, if the volume requirements are met.

Additional Criteria for Naturally Aerobic Lagoons

Loading rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be as indicated by AWMFH Figure 10-25 or according to state regulatory requirements, whichever is more stringent.

Operating levels. The maximum operating level shall be the lagoon level that provides the required volume less the 25-year, 24-hour storm event on the lagoon surface. The maximum drawdown level shall be the lagoon level that provides volume for the volume of manure, wastewater, and clean water accumulated during the treatment period plus the volume of accumulated sludge between sludge removal events. Permanent markers shall be installed at these elevations. The proper operating range of the lagoon is above the maximum drawdown level and below the maximum operating level. These markers shall be referenced and described in the O&M plan.

Depth requirements. The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons

Loading rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide a minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume less the 25-year, 24-hour storm event precipitation and shall not exceed the site and aeration equipment limitations. A permanent marker or recorder shall be installed at this elevation. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of the aeration equipment. This marker shall be referenced and described in the O&M plan.

CONSIDERATIONS

General

Lagoons should be located as close to the source of waste as possible.

Solid/liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal and method of sealing.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

Considerations for minimizing the potential for and impacts of sudden breach of embankment or accidental release from the required volume

Features, safeguards, and/or management measures to minimize the risk of embankment failure or accidental release, or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 2 might be significantly affected.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- An auxiliary (emergency) spillway
- Additional freeboard
- Storage volume for the wet year rather than normal year precipitation
- Reinforced embankment – such as, additional top width, flattened and/or armored downstream side slopes
- Secondary containment
- Water level indicators or recorders

Table 2- Potential Impact Categories from Breach of Embankment or Accidental Release
1. Surface water bodies – perennial streams, lakes, wetlands, and estuaries
2. Critical habitat for threatened and endangered species
3. Riparian areas
4. Farmstead, or other areas of habitation
5. Off-farm property
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places

The following should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 2 may be significantly affected:

- Outlet gate locks or locked gate housing
- Secondary containment
- Alarm system
- Another means of emptying the required volume

Considerations for minimizing the potential of lagoon liner seepage

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories listed in Table 3 may be affected.

Table 3 - Potential Impact Categories for Liner Seepage
1. Any underlying aquifer is at a shallow depth and not confined
2. The vadose zone is rock
3. The aquifer is a domestic water supply or ecologically vital water supply
4. The site is located in an area of carbonate rock (limestone or dolomite)

Should any of the potential impact categories listed in Table 3 be affected, consideration should be given to the following:

- A clay liner designed in accordance with procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1 x 10^{-6} cm/sec.
- A flexible membrane liner
- A geosynthetic clay liner (GCL) flexible membrane liner
- A concrete liner designed in accordance with slabs on grade criteria in NRCS Practice Standard 313, Waste Storage Facility, for fabricated structures requiring water tightness.

Considerations for minimizing the impact of odors

For sites located where odors are a concern, the following should be considered:

- Reduce loading rates of anaerobic lagoons to at least one half the values of AWMFH Figure 10-22.
- Covering the lagoon with a suitable cover.

- Using naturally aerated or mechanically aerated lagoons.
- Using composting in conjunction with a solid waste system rather than a liquid or slurry system.
- Using an anaerobic digester and biogas capture system.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is a potential for significant impact from breach or accidental release. The plan shall include site-specific provisions for emergency actions that will minimize these impacts.

APPENDIX P

BMP Description Sheets

APPENDIX Q

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